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ELECTRICITY ON THE ELEVATED ROADS.

Hard times and the competition of the surface car lines of New York City have for the past two or three years exerted a very adverse influence upon the receipts of the Manhattan Elevated Railway Company. This effect has, in turn, become a cause, and the secondary effect reveals itself in the action of the Board of Directors, on March 9, in reducing the dividend for the quarter ending March 31 from 1½ to 1 per cent. The only possible way for the Manhattan Company to regain its lost business is to adopt some improved form of propulsion, which practically means electric power, and the sooner this action is taken the better it will be, it seems to us, for the company—and the public, too. Before many months more shall have passed three of the main surface lines running in a direction parallel to the elevated roads will have been equipped with electric power, and, with these additional odds to contend with, the receipts of the elevated company will likely suffer further depletion, unless the company prepares itself to meet this powerful competition with at least an equally potent force. Under these circumstances, it seems like a loss of valuable time to experiment with air motors and petroleum motors as means of propelling trains. These are mere *ignes fatuii*, and hold out hopes that give little promise of commercial realization. On the other hand, electric power is tried and trustworthy, and is the ideal method of propulsion. To waste time in what seem to be practically useless experiments, before yielding to the inevitable, is a risky procedure, in view of the looming forms of giant competitors for the business at stake.

OFFICIAL LAMP TESTS.

That progress is being made toward placing incandescent lamps of the various manufacturers on a fair and equal basis, by the adoption of a secondary standard of illumination, is evidenced in the third interim report of President Nicholls to the members of the National Electric Light Association. An abstract of this report will be found elsewhere in this issue. No question of greater importance, both to the manufacturer and consumer of incandescent lamps, has been considered by Mr. Nicholls since his election to the presidency of the association, and it is to be hoped that the spirit with which this movement has manifested itself will continue unabated, and on the most liberal minded plans, that all interests affected will appreciate the work which it is desired to accomplish and show their appreciation by their hearty co-operation.

The problem of obtaining a definite sub-standard of illumination was first agitated by representatives of some of the most prominent lamp manufacturers, and was brought to the attention of the American Institute of Electrical Engineers a number of times, with the result that the matter was finally submitted to the standing committee on Units and Standards of the latter body, for the purpose of considering from a more or less scientific standpoint the question of fixing upon such a standard. This committee, we understand, has, after mature deliberation, arrived at the following conclusions: First, that for a primary sub-standard, the Hefner-Alteneck amyl-acetate lamp, issued and certified to by the Physikalische Technische Reichanstalt, be adopted; second, it is recommended that the Brodhun-Lummer screen be used; third, for commercial and practical use, incandescent lamps, compared with the Hefner-Alteneck primary standard, are to be

recommended for sub-standards, the rating to be ultimately based, as accurately as possible, upon the spherical candle power. In the measurement of the candle power of lamps the filaments are to be rotated at a speed approximating 150 revolutions per minute, this speed having been found to give the best results.

In a future joint conference, consisting of representatives of the American Institute of Electrical Engineers, the National Electric Light Association, the Association of Edison Electric Illuminating Companies, the lamp manufacturers and others, the practical and commercial aspect of the subject will be considered. The scientific part of the question having been settled by the American Institute of Electrical Engineers, it is intended, we are informed, to then take up the commercial considerations by a committee representing the remainder of the above mentioned bodies, this committee to determine what shall constitute the candle power rating of lamps, and also to make tests and certify over the signatures of its members to such tests of lamps to be used as secondary standards. The method of rating presents the most important question which yet remains to be acted upon, and one which offers the greatest difficulties, and inasmuch as it involves questions which are not likely to meet the views of all manufacturers, the committee so empowered must be thoroughly representative, and have sufficient influence behind it to make its decisions final. This committee should also have it in its power to formulate such rules as are found necessary to accord with the conditions from time to time. Thus, there will be placed at the disposal of manufacturer and consumer a definite method, when used under the proper conditions, of comparing the quality of incandescent lamps of different makes. If it should be found that ammeter and voltmeter readings give sufficiently accurate indications as to the constancy of the candle power of a secondary standard, the ease with which such tests can be made would seem to meet all the requirements, and at the same time enable those who do not care to avail themselves of a lamp testing bureau, which it has been proposed to establish, to carry out such tests as they may desire.

OBJECT LESSONS.

The burning of the Union Traction Company's power station, in Philadelphia, furnishes some very useful and instructive lessons to engineers, railway companies and municipalities. Great as was the misfortune of those owning the station, its loss may inure to the profit of the electrical fraternity if they will heed the obvious conclusions to be drawn from the accident and its sequel, and apply them in the construction of future installations of the kind.

It was very unfortunate that a chain dangling from an overhead crane should have short-circuited a large generator and started the fire. If it were necessary to have such a chain, it might, at least, have been so arranged that it could not strike the generator terminals, or the generator terminals might have been covered. An electric-generating plant is not a proper place for dangling chains or any other objects that may come into accidental contact with running machinery. It is also an invitation to accident to leave the terminals of a railway generator exposed.

If the short circuit had taken place in a plant having a slate or cement floor, a burned-out armature and, possibly, a bent connecting rod on the engine would have been the worst results. The pyrotechnical display would have been harmless, though terrifying. In this unfortunate plant, however, the floor was of wood—Georgia pine—soaked in the accumulated oil drippings of several years' service, and inflammable to the highest degree. The hot particles of metal flying from commutators and brushes under the strain of the short circuit, fired it in a dozen places, and the flames, spreading almost instantly, drove out the attendants. When the Fire Department got to work on the blaze, the plant was already in ruins.

There is a vast deal too much cheap construction in central stations in this country. It is doubtless impossible to construct a really fireproof building, but it is an easy matter to make a station building proof against any ordinary cause of fire. The peculiar fire risks surrounding the operations of dynamos would seem to make it imperative that they should be placed in situations free from the dangers of combustion. In a plant costing nearly one million dollars, the additional expense for a proper floor for the dynamo room would have been insignificant. The loss of patronage entailed upon the company in this instance is probably many times the small cost of such a floor.

If each dynamo had been equipped with a proper circuit-breaking device, fuse or magnetic, at its terminals, the accident would, in all probability, have been avoided. The circuits from the dynamos to the switchboard contained circuit breakers, but they were mounted on the board itself, and hence useless in case of a short circuit at the machine terminals. Dynamo builders and station men might derive much benefit from a consideration of this fact and its bearing upon the Philadelphia conflagration. At present there seems to be no manufacturer providing his dynamos with protective devices within the machines themselves, reliance being universally placed upon external devices.

Perhaps the most prominent fact demonstrated in connection with the misfortunes of this plant is the flexibility of the trolley system. Within a few hours after the destruction of the central power station of its vast system of railways the Union Traction Company had every one of its lines in operation. There was no general stoppage of the arteries of urban transportation, impeding business and engendering protest. The fact that such recuperative powers are possessed by the electric railway was never before so forcibly illustrated. It is true that the resources of the company were magnificent, but it is inconceivable that any system having motive power other than electricity could recover from such a blow within weeks, or even months. Such an accident in a cable power house would have meant a prolonged, entire suspension of traffic. The forethought of the engineers, who guarded against the disastrous results of such an accident with a complete system of intercommunication between power houses, is to be highly commended. It is most unfortunate that their precautions did not include a fireproof floor in the dynamo room of their power station.

The Telegraph in Spain.

The excellence of the telegraph service in America stands out in strong relief when compared with the telegraph service in Spain. This latter country does not stand very close to the front rank of progressive nations, so it could hardly be expected that its telegraph system should be any better than the condition described by the Madrid correspondent of the London *Times*. The Spanish telegraph system, he says, has always been a crying scandal, and, instead of improving with the times and the advance of science, it appears to get worse. Ordinary atmospheric disturbances are sufficient to render inoperative the greater part of the lines throughout the country, while a heavy fall of snow or a gale of wind generally results in complete paralysis of the whole service. Under this condition of things, the correspondent states, it would naturally be supposed that the authorities would not place any additional difficulties in the way, and that the public convenience would be to some extent considered. But not so. The censorship at the Home Office is exercised without the slightest discretion being used affecting the contents of telegrams detained. Two telegrams to the *Times* were recently detained nine hours.

The Selection of a Power Plant Steam Engine.

A lecture on the above subject was delivered by Prof. Hutton, of Columbia University, at a recent meeting of the Electrical Section of the American Institute, in conjunction with the Henry Electrical Society, at the rooms of the American Institute, No. 111-115 West Thirty-eighth Street.

Three questions were particularly considered. The arguments for and against high and low-speed engines, automatic cut-off engines as contrasted with throttling engines, and the arguments in favor of condensing engines. The lecturer did not have time to discuss compound engines, as was intended. The principles underlying work and heat motors and a thorough explanation of the well-known formula $HP = PLAN + 33{,}000$ were discussed.

With horse-power fixed, both A (piston area) and L (length of stroke) would diminish as N increases. Engines embodying this feature are named high (rotative) speed engines.

Such engines have a small cylinder volume, because they are frequently filled; they also have small cylinder lengths and diameter, which makes the engine light.

The small cylinder lengths make a short engine, because the crank and connecting rods are correspondingly shortened. The small diameter of the cylinder, however, increases the strain on the piston rod and connecting rod, and lightens them. The diminished weight of reciprocating parts secures a steadier and quieter running without increasing the initial pressure. Summing up the above points, we may say that the weight and bulk of the engine are diminished. The horse-power can be increased without decreasing the weight and bulk by increasing the pressure.

High-speed engines can be run with less change of speed ratio in the transmission, and, in fact, in some cases without transmission gearing, being direct connected.

When the engine speed exceeds 120 strokes per minute, each revolution is made in less than one second. The variation, therefore, in effort or resistance is more promptly met and adjusted to secure constant speed. The variation of effort and resistance has not sufficient time to get far away from the mean effort of the minute before a readjustment occurs.

The regulation and governing mechanism by which the effort of the steam and the resistance are adjusted to each other does its work more promptly in a high-speed engine than where it derives power from masses of more weight at less velocity. The heavier masses are more sluggish from inertia and have more friction from their weight.

The term "high speed" has been generally used in the sense of high speed of rotation, and not necessarily in the sense of high speed of piston. If L and N (number of strokes per minute) be increased together, but not N alone, there results a design of engine of small diameter of cylinder, but of relatively long stroke. Of this type of engine the Corliss stands as a prominent example in stationary practice. Here N is kept low on account of the valve gears. The typical beam engine used in river boat practice and also pumping engines are other examples of this class of engine, which are generally known as slow-speed engines. The arguments in their favor are the arguments to be used against the high rotative-speed engine. Some of these features are as follows:

Increasing L relatively to A and keeping N low diminishes the loss of cylinder condensation.

The clearances do not have to be as large.

Port areas can be cut down because the linear velocity of the steam is less.

The last two features diminish clearance wastes, less steam being lost per stroke, and there are fewer strokes.

In the high speed engine with short traverse, all bearing surfaces are traversed more frequently and the weight is concentrated over a smaller area. Close attendance and excessive lubrication are therefore required, and the workmanship of such engines must be of a particularly high standard, making them costly.

When an accident happens to a high speed engine, the high speed in many cases prevents any possibility of prevention.

In summing up these various features the result would seem to be that if close regulation, light weight and direct connection are worth most, high rotative speed should be used, but if economy, long life and peace of mind are worth most, then the long-stroke, slow-speed engine should be used.

A piston speed below 500 feet per minute may be considered low; from 600 to 800, moderate; and above 900, high.

Some automatic governing device must be provided to meet the demands of varying load on the engine. In general practice this is accomplished by throttling the steam supply or by a variable steam cut-off valve. The mean steam pressure on the engine cylinder is the only variable quantity that can be controlled practically.

The diagram of effort in the cylinder is shown by the indicator diagram. The energy of the steam expended in the engine is represented by the area of the diagram. The variation of height in this diagram shows a variable initial pressure such as would be produced by throttling. In such cases the steam cut-off remains constant and such engines are known as throttling engines. Automatic devices may be used to operate the throttle or it may be operated by hand.

The area of the diagram can also be varied by varying the cut-off at various points of the stroke. That is, the length of time during which the maximum pressure is maintained. In such engines the valve controlling the steam inlet to the cylinder is made variable so that at low loads the steam is cut off at a very small percentage of the stroke, while at larger loads or full load, the valve remains open for some time.

The advantages in favor of throttling engines may be enumerated as follows:

They are cheap to build and to buy; the valve gear may be exceedingly simple; the steam follows with maximum effort for a long distance and is less irregular.

Superheating and drying of the steam occurs when the high temperature steam suddenly finds itself at a lower pressure, as occurs when throttling is resorted to. This produces less cylinder condensation than where the automatic cut-off is used.

The disadvantages of the throttling engine are as follows:

They are less sensitive to instantaneous variations; they do not regulate as closely; the exhaust carries away more heat because the maximum has lasted through a comparatively long portion of the stroke and therefore, a lower efficiency results from the steam used.

The advantages of the variable cut-off engines are as follows:

The steam effort is controlled at each stroke, and keeps the speed quite fixed.

The full boiler pressure acts without waste of energy upon the piston and without loss from friction due to throttling.

Superior economy is possible with such engines from less weight of steam than would be used in the throttling engines.

Among the disadvantages of the variable cut-off engines are the following:

As the maximum steam pressure in the cylinder is always at one point, wide differences of energy exist between the two ends of the cylinder. Heavy fly-wheels are therefore necessary with resultant increased friction.

The valve gear of such engines is usually complicated, making the engine costly to build aside from the necessity of superior construction in the other elements of the engine.

The low final temperature or pressure of the exhausting steam in the cylinder increases the cylinder condensation.

In some cases the expansion is more than complete, necessitating negative work.

In a condensing engine devices are provided for creating a vacuum in an exhaustion chamber into which the steam from the engine cylinder passes. By this method the atmospheric back pressure is eliminated and the effective pressure of the steam is therefore greater. Other advantages of such engines are:

Smaller cylinder for same power; complete expansion from same initial pressure and yet earlier cut-off and less steam per stroke from short admission; less heat is rejected at the exhaust; a higher efficiency is possible because the final temperature of the exhausted steam is less.

Condensation gives pre-heated water for boiler feeding, as the latter must be used in most cases for condensing the exhausted steam in the vacuum chamber.

Amongst the disadvantages of condensing engines are: The cooling of the cylinder by a lowered final temperature makes an increased initial condensation.

The apparatus to maintain the vacuum in the exhaustion chamber is usually complicated and necessitates power for its operation.

Where the exhaust steam is returned to the boiler, trouble frequently occurs from oil therein which should be entirely separated from the water before the latter is fed to the boiler.

The condensing engines are usually limited in their application to places where cooling water can be had in large quantities.

Such engines are generally operated at low rotative speed, which is limited by the condensing appliances.

The compound engines were not considered for lack of time. The lecturer hoped to consider this subject at some future date.

A Simple Way of Testing the Resistance of a Field Coil When Instruments are not Available.

BY FRANK B. PORTER.

In many street railway motor repair shops there is a complete absence of instruments with which to measure the electrical resistance of the winding of the armature or fields of a motor, so that a person whose duty it is to discover what is wrong with a motor when it is brought to the shop for repair in many instances guesses that the armature is burned out, or that the field is internally short-circuited through some of its layers. The armature or field coil is then taken out and a new one substituted, sometimes remedying the difficulty, and sometimes leaving the motor as an object for future experiment.

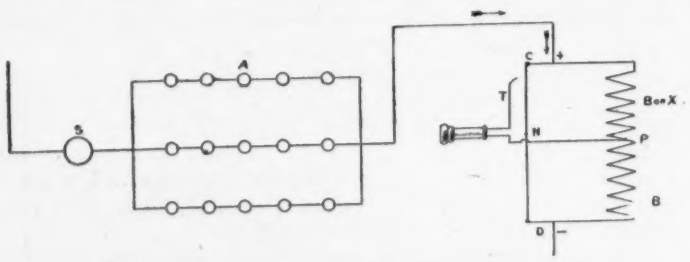
The following is a simple device for testing the electrical resistance of a field, which for the cheapness of the materials employed and simplicity of operation may commend itself to many when more expensive instruments are not available.

Let *A* be a bank of lamps, say three circuits in parallel, as street railway circuits are usually in the neighborhood of 500 volts. We will say there are five 100-volt lamps in series in each circuit, and supposing there is 0.7 ampere in each circuit, we will have a total of 2.1 amperes for our test.

Let *B* and B^1 be two standard fields connected in series, of the same type as the one to be tested, being any two fields about the shop that are known to be perfect and of the same type. Let *CD* be a length of German silver wire, connected in parallel with *B* and B^1, and of about the same resistance.

Let *R* be an ordinary telephone receiver, with one terminal connected between the two fields *B* and B^1 at *P* and the other terminal *T* insulated, except near the point, so it can be taken in the hand. Let *S* be a switch with which to close or open the circuit.

To test, close the switch *S* and, putting the receiver to the ear, tap the terminal *T* along the wire *CD*, until a point is reached where the receiver will not give forth a click as you tap, say at *N*. Now remove field *B* and substitute the field to be tested, and touching the point *N* with terminal *T*, if the field being tested is of exactly the same resistance as *B*, there will be no click in the receiver; if there should be, however, tap terminal *T* on each side of the point *N* until a point of no click is found, and as it is nearer *C* than the point *N* is, or further from it, so is the resistance of the field you are testing, proportionately less or greater than the resistance of the standard field *B*.



Method of Testing the Resistance of a Field.

If the wire *CD* were laid off to a scale, *i. e.*, its resistance marked in different lengths, in ohms and fractions of an ohm, when the place of no click was determined, using *N* again as that place, with a field of unknown resistance *X*, to be tested in place of *B*, and the resistance of B^1 being known, the equation follows:

$$\frac{CN}{ND} = \frac{X}{B^1} \text{ or } X = B^1 \frac{CN}{ND}; \text{ if } ND = B^1, \text{ then } X = CN,$$

or to put it arithmetically, the resistance of the field *X*, equal the resistance of the wire from *C* to *N*, multiplied by the resistance of the field B^1, divided by the resistance of the wire from *N* to *D*.

In this last case the resistance of the wire connecting *CD* with the fields *X* and B^1 should be practically nothing, large wire could be used, a few inches at each end being sufficient, the terminals of the two fields at *P* could be connected together, and, of course, all connections should be well made and the current constant.

As large a current as can be used, without producing a heat error and with safety to the receiver would be preferable to a very weak current and give better results.

A larger bank of lamps might be used, with a switch for each circuit and a suitable fuse for safety inserted in the main circuit.

All of the material used for this test other than generally found in a street railway repair shop, is a telephone receiver and a few feet of German silver wire. These can be procured at a small cost. The use of a telephone receiver and vibrator in place of a galvanometer is capable of considerable development, and though not as sensitive as the delicate higher priced galvanometers, they are much superior to the cheaper article, costing much less and standing much harder usage without getting out of order.

President Nicholls' Third Interim Report to the National Electric Light Association.

In his third interim report to the members of the National Electric Light Association, President Frederic Nicholls refers to the meeting held last Fall for the purpose of discussing the question of standardizing the incandescent lamp socket and lamp base, an account of which appeared in The Electrical World of Oct. 17, 1896. He proposes to call another meeting at an early date at which the committee appointed at the last meeting will report progress. The President announces that the report of the Committee on Data has been completed. This report is now in the printers' hands and will be ready for distribution some time prior to the convention to be held at Niagara Falls on June 8, 9 and 10 next.

Dr. Louis Bell, Chairman of the Committee on Incandescent Lamp Standards, reports that the subject was taken up with the Units and Standards Committee of the American Institute of Electrical Engineers, the fundamental question considered being the establishment of a standard method and apparatus for the measurement of candle power. This, Dr. Bell states, has been satisfactorily settled, and it now remains to arrange for the production of secondary standards (*i. e.*, standard incandescent lamps to be used for purposes of comparison) and to draw up specifications for a uniform rating of lamps and its ready verification. A joint conference of a committee of the National Electric Light Association will be held with the official representatives of the American Institute of Electrical Engineers and lamp manufacturers, so that final conclusions may carry the joint agreement and assent of these organizations.

Plans for establishing a lamp-testing bureau have been submitted to President Nicholls by a member of the Association, which he gives in full, and requests the opinion of the members regarding the merits and demerits of the suggestions which are offered. It is proposed to establish a bureau which will be in charge of an expert employed by the National Electric Light Association, the methods of testing to be approved by a majority of experts of lamp manufacturers who agree to abide by decisions of the bureau as to quality of product and fulfillment of guarantees. The expense of maintaining the testing bureau will be met by the income of the bureau, and partially met by subscription or definite dues from central stations or other consumers, who would signify their intention of availing themselves during the year of the services of the bureau. Lamp companies will be at liberty to guarantee their product at as high a standard of quality as they see fit, and the province of the bureau would be to determine whether such guarantees have or have not been fulfilled. The conditions under which it is proposed to carry out the tests are then given. Those who have an interest in this matter should communicate with President Nicholls for the purpose of obtaining details of the specifications.

The following is a list of the papers which President Nicholls states will be read at the Niagara Convention. Copies of these papers will be furnished to members some time before the date of the convention:

"Municipal Lighting," by W. Worth Bean; "Standardizing Prices for Incandescent Light and Power," by J. B. Cahoon; "Correct Method for Charging for Product," by C. L. Edgar; "Cost of Delivery of Current from Station to Consumer," by W. S. Jewell; "The Daylight Work of Central Stations," by T. C. Martin; "Electrical Development at Niagara," by L. B. Stillwell; "Recent Progress in Arc Lighting," by Prof. Elihu Thomson; "The Niagara Power Transmission Line," by J. G. White; "The Induction Factor; a New Basis of Dynamo Calculation and Classification," by Prof. Wilson, of McGill University, Montreal, and Charles A. Carus; "The Profitable Extension of Central Stations," by Arthur Wright, president of the Municipal Electrical Association, England.

The Regla-Pachuca Power Transmission—I.

BY GEORGE J. HENRY.

IN many of the mining regions of Mexico, and especially in the districts that have been worked for several hundred years, the demand for wood, the only available fuel, has overtaxed the supply to such an extent, that the country, which originally was but scantily timbered, can no longer be relied upon, and it has become necessary to import coal at a very great expense, with the result that many of the mines carrying what may relatively be termed low grade ores, have practically been shut down, until cheaper fuel or motive power can be obtained. Only those properties carrying very rich ores can be worked at a profit.

It will, therefore, readily be seen what a vast field would be opened up by cheap fuel—or its equivalent, cheap and reliable motive power; this applies equally as well to mining properties already developed, but which, for the reasons above cited, cannot be profitably operated under existing conditions, such as new discoveries, and the more profitable operation of the older and richer mines, whose ore in some instances has run as high as one thousand to two thousand ounces to the ton.

Notwithstanding her enormous mineral wealth, the richness of her soil, and variety of her climate, the scarcity of fuel and lack of adequate transportation facilities, have seriously retarded the growth and development of Mexico. What inducement is there for the farmer to plant and harvest crops when the cost of bringing them to market more than equals the price he can obtain? What inducement is there for the capitalist to invest his money in mining properties when none but the richest mines can be made to yield a profit?

As an offset to the cost and difficulty of transportation and the scarcity of fuel there is, however, an unlimited amount of cheap labor, and in many districts ample water powers; these unfortunately are not often found at the point where they are most wanted; but, now, when the practicability of the electric transmission of power has been so thoroughly and frequently demonstrated, when power can be transmitted distances of thirty-five miles and more with a loss less than that involved in the transmission of power throughout large factory buildings by means of shafting, pulleys and belting, there is nothing wanting to insure the development of this wonderful country but capital. With it, the power of hundreds of mighty torrents could be made available at distances of from forty to fifty miles and more. In fact, almost every square mile of valuable territory could be reached. All along the border of the tableland of Mexico, and especially on the eastern slopes where the land falls away rapidly to the sea, will be found excellent waterfalls that, by means of electrical transmission, may be made available at very long distances.

The distance to which power can be transmitted profitably in any particular case, will depend on the cost of original development, the cost of fuel at the terminal points and the value of power; but the perfect practicability of long distance transmission of power by electricity, will serve in very many cases to place the mining of low grade ores on as profitable a basis as the mining of rich, high grade ores, as at present worked, and will also bring a much greater profit to the owners of the richest mines.

It is the purpose of this article to give a complete description of a high head water power and electric transmission plant, now in successful operation in Mexico, and in so doing to point out what a vast improvement may be effected in the development of the mining and other industries, in localities difficult of access, and where fuel is scarce and high in cost.

The mines owned and operated by the Real del Monte Mining Company near Pachuca, State of Hidalgo, have long been noted for the richness of their ores, and have been worked for several hundred years. The railroad terminus is at Pachuca, whence an old Spanish road, built over 200 years ago, leads over the mountain ridge to the quaint and picturesque town of Real del Monte, nestled among the rugged summits of the mountain range that Humboldt has called the backbone of the continent. The mines are numerous in this section and a good freight-road, constantly used by freight teams loaded with ore, and also by the peasants going back and forth to the markets with their agricultural products, leads to three old Haciendas de Benificio.

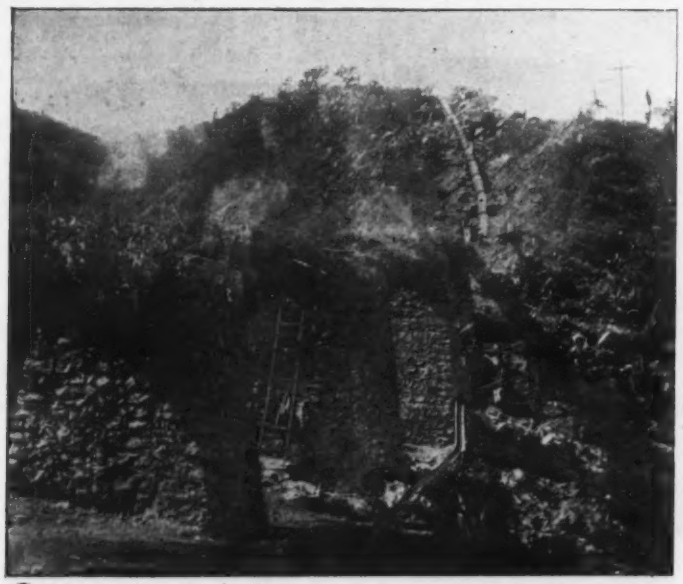
Owing to the great fall in the price of silver during the last few years, and the consequent depreciation in the value of the output of the mines, it became necessary for the company to adopt the most improved processes for the treatment of its ores, as also to effect, wherever possible, an economy in the cost of production and reduction. In a few instances the Haciendas de Benificio, or reduction works, have been operated by old overshot water wheels, installed originally at an enormous monetary outlay, and their output representing at best but a small fraction of the reduction work done on the ores of the Real del Monte mines. All the other power required for the reduction of ores, and for the operation of the many hoists, pumps, etc., is supplied by steam with coal at $22.50

HEAD-WORKS OF CANAL, SHOWING TWISTED VOLCANIC STRATA.

GENERAL VIEW ALONG LINE OF CANAL.

a ton in silver, amounting to about $11.50 in gold, laid down at the boilers. With coal at this figure, the cost of steam power exceeds $225.00 per horse-power per year, and the opportunities for a profitable electric power transmission plant became apparent to the mine owners, and a company was consequently formed for the development of the scheme. After numerous preliminary surveys, a site was finally chosen on the Regla river, immediately below the haciendas above mentioned, as the most favorable location for a power plant. This river has its source in a most romantic old Spanish garden, in springs of crystal clearness on a bank of exquisite semi-tropical foliage, and flows thence for several miles through ancient stone aqueducts, falling over the overshot wheels of one hacienda after another, at the same time gathering the tailings from the roasted silver ores. At a distance of about three miles from the springs, it suddenly plunges from the mesa into a barranca of the most rugged nature and in a distance of less than a mile, falls in successive cascades, ultimately reaching a point of 1200 feet below the mesa. Immediately on leaving the aqueducts of the old Hacienda de Regla, the river enters the headworks of the canal of the Power Transmission Company's plant. This canal runs along the precipitous cliffs on one side about 300 feet below the top of the canon, and it was necessary in order to find a suitable foundation below the top strata, to lose this 300 feet of the fall.

This top strata is a very interesting geological subject. The whole surrounding country appears to be the result of repeated volcanic eruptions and overflows of lava, twisted and turned in the most fantastic forms, and capped by a deep strata of basalt columns of beautiful regularity and exceptional height. Occasionally portions of these columns become loosened and fall with a roar like an avalanche to the river below. A canal could not have been built on the ground surface without very expensive filling and cutting, and no tunnel would stand in this vertical strata. A heavy masonry dam was built in the canon at a point where the river takes a sudden leap between two walls of rock, and here the necessary gratings, headgates and overflow were placed. The canal from these headworks to the forebay is 2400 metres long, 630 metres of which are through tunnels in solid rock, eleven in number. The cross-section of the canal is 1.25 by 1.25 metres, with walls on each side of broken stone set in a mortar of lime and a red sandy material found in the vicinity, while the bottom is finished throughout with cut stone slabs. The fall in the canal is 0.4 per cent. making 9.6 metres total drop. At one point in the canal, where it issues from one tunnel, it has to span a chasm 60 feet



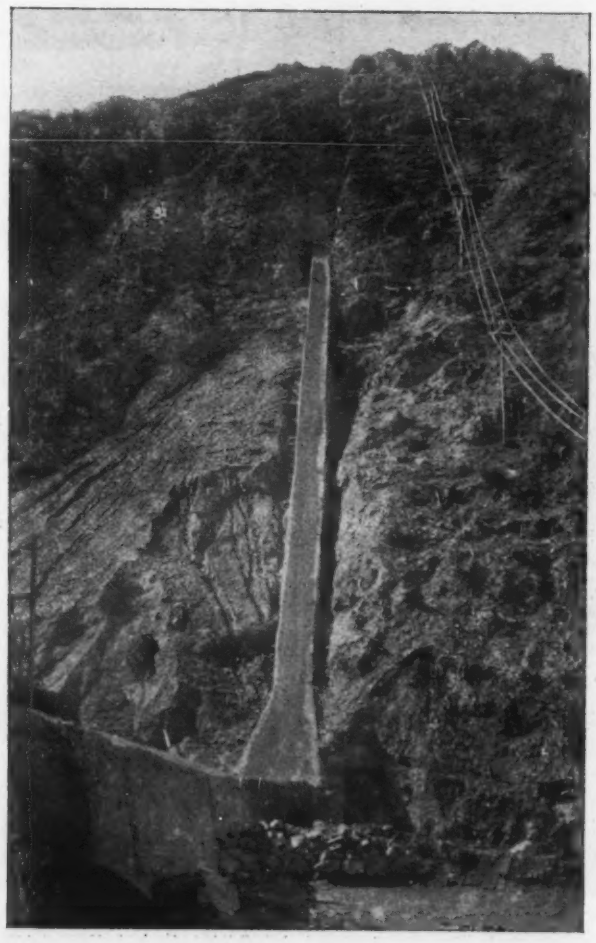
Pipe Line on Masonry Supports and Covered with Brush.

wide to the entrance of another tunnel, and here a masonry pier 75 feet high, arching to either wall, was constructed to carry the canal.

After leaving the tunnels, the canal skirts along a very steep hillside of loose material that falls away in great landslides with every rain. A number of test holes were driven, but it was practically impossible to reach the bedrock. Excavation was, therefore, made about ten metres in the hill for the canal, which was afterward covered over with I-beams and corrugated iron, with about a metre of loose filling on top.

The overflow is situated just outside of the last tunnel before the loose earth is reached, and on a good rock foundation. A float to stop leaves and light floating material is situated in front of a grating, and at an angle just behind the overflow, keeping the surface of the canal clear at all times. From the overflow to the forebay, the sidewalls of the canal are run level to prevent any possibility of overflow on this loose foundation material. Another grating is placed at the forebay and also three five-eighths inch bars vertically across the entrance to the pipe line.

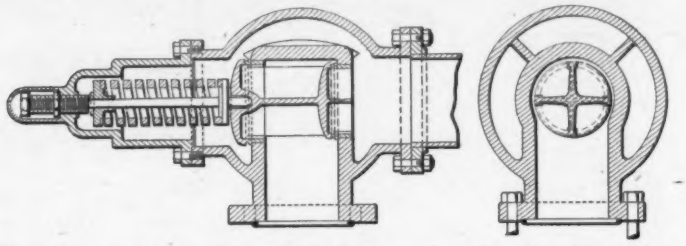
The pipe line is 30 inches in diameter, throughout its entire length of 2200 feet, and is made up in sections each 30 feet long, connected together by steel angle iron flanges, recessed for three-eighths inch soft copper gaskets. After the flanges were pulled up by three-quarter inch bolts against the copper gaskets, the latter were calked from the inside, and, it is a noteworthy fact that not a single one of these flanges leaked a drop, even under the 350 pounds per square inch pressure at the bottom of the hill. The pipe is made of steel plates of thickness varying from three-sixteenths to three-fourths of an inch, proportioned to the pressure, double riveted in the axial seams, and single riveted in the round seams. The pipe, in the upper half of its length, falls but 200 feet, and for a distance of several hundred feet is carried on heavy piers, and is anchored in heavy blocks of masonry. In the lower 900 feet of the pipe line the fall is 608 feet, on a loose, earthy hillside, and here to secure proper anchoring became a very serious problem. It was finally solved, however, by building masonry piers deep in the hillside, and bedding the pipe in their tops, each section of pipe carrying lugs to take up the end thrust. Above the pipe lateral retaining walls are run, and loose earth filled in against them, the latter designed to prevent landslides during the rainy season, which is very severe.



Lower Portion of Pipe Line Showing Retaining Walls Above and Masonry in Which Pipe is Buried Below.

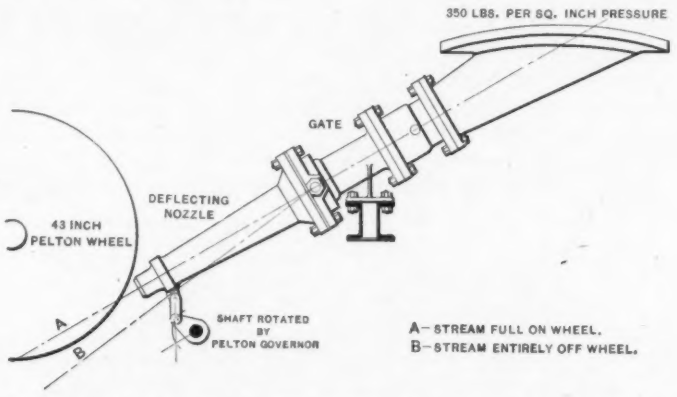
Over the last 300 feet on this hillside, as shown in the illustration, the piers are placed close to each other, and the whole pipe line imbedded in masonry, thus taking up the downward thrust most effectively. At the foot of the hill the pipe runs along on a solid wall of masonry which, at the same time, is used as a protecting bulkhead for the power house. A thirty-inch gate valve is provided at the end of the pipe, and to the other side of this valve the receiver is connected. The valve was tested to 500 pounds per square inch static pressure at the factory, and is fitted with a 2.5-

inch by-pass, so that the receiver may be filled in advance of opening the main gate. It is, however, possible to open the main gate by hand if necessary. A 36-inch hand wheel geared to a 2.75-inch Tobin bronze valve spindle by one-to-six mitre gearing is provided



PIPE RELIEF VALVE FOR 30-INCH PIPE, 350 LBS. WORKING PRESSURE.

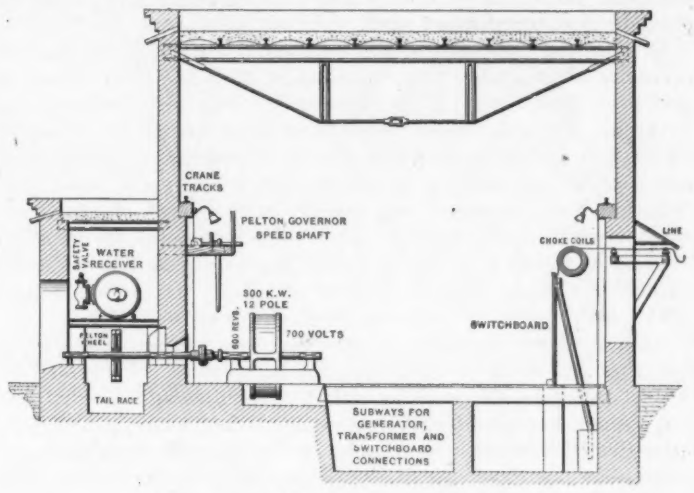
for handling the main gate. It is to be noticed that there is a working pressure on the valve of this gate of about 140 tons. Immediately in front of the gate, and on the last length of pipe, a double disc safety valve connected to the pipe by a six-inch cast steel flange is placed. This valve is of peculiar construction to meet the requirements of the installation, which it does admirably. A little attention to the illustration will show that when this valve opens, a very large



DIAGRAMMATIC VIEW OF DEFLECTING NOZZLE AND CONNECTIONS.

area permits discharge (*i. e.*, about 20 square inches for one-half inch compression of the spring). Phosphor-bronze rings serve as seats, and a non-corrosive spring wound for working pressure, proportioned to the difference in area of the valves (which nearly counterbalance each other), keeps the valve on its seat. The tension on this spring may be adjusted by the set-screw on top. Under test, the valve opened at three per cent. increase in pressure, and closed gradually as the pressure was reduced. During the installation of the pipe line, it was kept covered with earth where possible and shrubbery where it ran on top of the piers, to prevent damage by heat expansion.

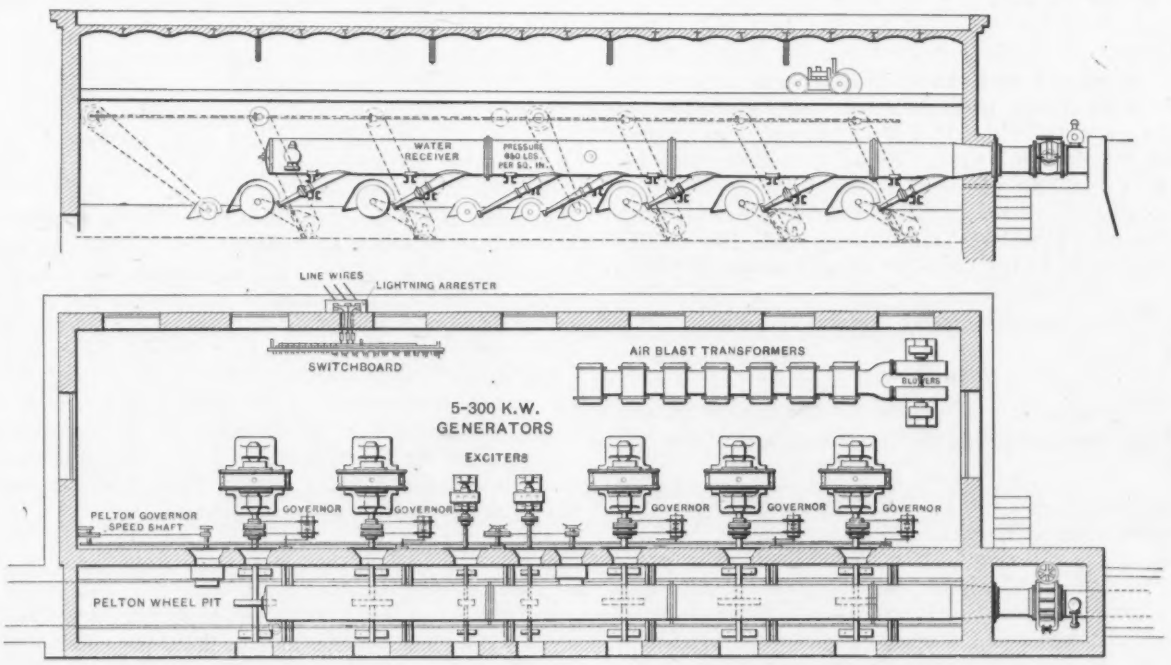
The pipe line and main gate discharge through a short taper-piece into a receiver 40 inches in diameter and 75 feet long, made of flange steel plates ¾ of an inch in thickness, riveted up in four lengths, and joined by recessed flanges of rolled steel bolted together with 52 1½-inch bolts each—the joints being made tight by ½-inch round soft copper gaskets, which were carefully calked after the bolts were drawn up. Access may be had to the interior through a manhole provided at the lower end. This receiver also carries a safety valve, a duplicate of the one above described. On the



SECTIONAL VIEW OF POWER STATION.

under side of the receiver, there are seven cast-steel taper pipes, or nozzles, projecting down at an angle of 30 degrees. Five of these have flanged outlets five inches in diameter, and the remaining two flanged outlets three inches in diameter. To the former are connected the individual gates and nozzles leading to five Pelton wheels. These five main wheels are 43 inches in diameter, and have a capacity of 600 horse-power each, with a single stream of 2.66 inches. The speed of the wheels is controlled by a deflecting nozzle, by means of which the stream can be moved on or off the wheel; this movement being effected automatically by the Pelton differential governor, and as rapidly as circumstances may require, without in any way affecting the pressure on the pipe. A gate valve in each nozzle allows each wheel to be controlled at will from the interior of the power house.

To each of the smaller nozzles is connected a gate valve, from which two 24-inch wheels are operated; these two wheels drive the exciters. The gates of all these wheels are operated by means of



ELEVATION AND PLAN VIEWS OF THE POWER STATION.

spindles extending through the walls into the dynamo room, in which the governors are located, so that the entire plant can be controlled with the greatest facility by the station attendant.

In addition to those above mentioned, there are two 24-inch wheels which may be termed constant speed motors. When the plant is in operation one or the other of these wheels is always running, its duty being to provide a small amount of power and practically constant or uniform speed for the differential governing mechanism. This constant speed is maintained through small variations in power, by means of a heavy flywheel on each of these so-called constant speed motors, as also by a number of flywheels on a shaft which runs the entire length of the power house, at right angles to the shafts of wheels and dynamos, and which may be termed the constant speed shaft.

To this shaft one side of the differential governing mechanism is connected, the other side being driven from the water wheel or generator shaft that is to be governed. This Pelton differential governor, briefly described, consists of four mitre gears meshed together in such a manner that the two gears opposite each other when rotated in contrary directions, but at the same speed, will cause the two intermediate gears to rotate exactly at the same speed also, these intermediate gears being mounted on a crosshead keyed to the shaft, on which the two side gears are run loose on quill shafts. As long as the two side gears are running at the same speed, though in opposite directions, one being driven from the water wheel shaft, the other from the constant speed shaft, the crosshead remains stationary, but if a portion of the load be thrown off from the water wheel, the result would be that the side of the governor driven from the water wheel would run slightly faster than the constant speed side, and revolve the crosshead perhaps only a fractional part of one revolution, but sufficient to cause a pinion on the crosshead shaft to impart a slight motion through a quadrant to a rockshaft, to which the deflecting nozzles are connected by a simple system of levers.

All of the wheels, nozzles, and receiver are housed in, the outer walls being arched over all the outboard bearings. These arches allow free access to all the wheels and other hydraulic machinery while the plant is in operation, a very advantageous feature.

From the accompanying illustration will be seen the general scheme of arrangement. The wheels are immediately above the tail race, so that the water falls freely from them. They are almost entirely inclosed in housings made of sheet steel to prevent the water being thrown when a change of speed occurs. The receiver is directly above the wheels, and is supported by a number of steel I-beams, carrying suitable saddles. The I-beams rest on masonry columns built against the walls.

The tail race is three feet wide, and two feet deep, and is lined with two-inch planks throughout, backed up with three inches of best Portland cement and sand in equal parts; at the point under each wheel where the stream, when deflected, would strike the bottom of the tail race, a steel plate, 12 x 26 inches and three quarters of an inch thick, is bolted; this precaution being necessary, as without it the tail race would soon be washed out.

The five generator wheels run in special self-oiling bearings, and are keyed to hammered steel shafts, which are each directly connected by a flexible insulated coupling to a three-phase 300-kw General Electric twelve-pole generator, running at a speed of six hundred revolutions and generating 247 amperes at 700 volts difference of potential.

(To be Continued.)

Elevated and Surface Roads to Use Brooklyn Bridge.

At a meeting of the New York and Brooklyn Bridge trustees, on Mar. 9, the report of Chief Engineer Martin concerning the feasibility of permitting the elevated and surface electric cars to use the bridge was adopted. This report concedes the entire feasibility of using the bridge for these cars, but urges the building of a new bridge, for their use exclusively, near the present structure. The report of a sub-committee, based upon expert examinations of the structure and conditions, and favoring the concession of rights of way for the surface and elevated cars, was also adopted. The only further step to be taken in the matter is for the companies and the bridge trustees to agree upon the amount to be paid for the privilege. An illustrated description of the plans for running trolley cars over the bridge was published in The Electrical World of Jan. 23, 1897.

Alternating-Current Machinery.—VI.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

Chapter VI.

CONNECTION IN SERIES OF CO-FREQUENT SIMPLE-HARMONIC E. M. FS.

WHEN two continuous E. M. Fs., one of say, 100 volts, and the other of say, 40 volts, are connected in series, the total resultant E. M. F. is either 140 volts or 60 volts, according to their relative directions; that is to say, whether in aid or in opposition to each other.

When, however, two alternating E. M. Fs. are connected in series, the resultant total E. M. F. is more complex. Even when each of the two E. M. Fs. is sinusoidal, and they have the same frequency, the E. M. F. may have any value between their sum and their difference, according to the phase of the E. M. Fs. so combined.

60. We may suppose that two sinusoidal generators, say of the type represented in Fig. 23, be rigidly coupled together mechanically, and driven at the same speed, with their revolving coils connected in series. We may first consider that they are in phase with each other, so that when the E. M. F. of one armature is say, at its maximum positive value, so is the other. Then the resultant total E. M. F. is the same as though but a single armature were employed with twice the E. M. F. In other words, the generator so

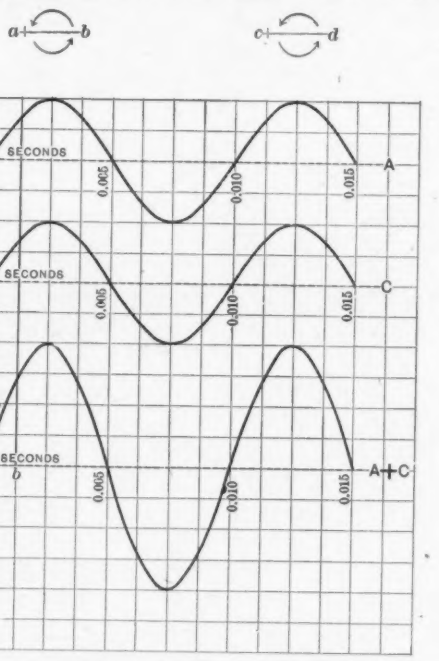


FIG. 28.—SUM OF TWO EQUAL CO-PHASE CO-FREQUENCY SINUSOIDAL E. M. FS. $10 \sin (200 \pi t) + 10 \sin (200 \pi t) = 20 \sin (200 \pi t)$.

constituted has twice the E. M. F. of each component, and the same phase as either of them. This is represented in Fig. 28, where *ab* and *cd* represent the relative positions of the revolving coils, at the instant when *cd* is horizontal. *A* is the sinusoidal E.M.F. of 10 volts amplitude (¶ 11) of one armature, having a frequency 100∼, or $A = 10 \sin (200 \pi t)$ volts. *B* is a similar sinusoidal E. M. F. of 10 volts amplitude, and the same frequency, having also the same phase, or $B = 10 \sin (200 \pi t)$ volts, while $A + C$ is the resultant total E. M. F. or the sum of *A* and *C*, so that each ordinates on the *A* and *C* curve, is the sum of the corresponding ordinates on the *A* and *C* curves. Thus it will be seen that $A+C$ has twice the amplitude of either *A* or *C*, and $A + C$ is a sinusoidal E. M. F. of 20 volts amplitude, and 100∼, or $A + C = 20 \sin (200 \pi t)$. Thus at *b*, 0.00125 seconds from the start, the phase is $\pi/4$, and $A = 10 \sin \pi/4 = 7.07$; $B = 7.07$, and $C = 14.14$.

61. We may next suppose that the two armatures are rigidly coupled together, but that the plane of the coil in one is at right angles to the plane of the coil in the other. This will cause the E. M. F. in one to be at 90° phase difference in respect to the E. M. F. in the other; so that when one E. M. F. is at its maximum, the other is at zero. The planes of the two coils will, therefore, be relatively to each other, as shown at *ab* and *cd* in Fig. 29, where the plane of the coil *cd* is horizontal. Here *ab* is in advance of *cd* by 90°; or, if we advance *cd* through 90°, without moving *ab*, we would bring both

into step. If we plot the two component sinusoids shown at A and C, and then sum them algebraically as shown at $A + C$, we obtain a sinusoidal curve as before, but the amplitude of $A + C$ is 14.14 volts, or $\sqrt{2}$ times the amplitude of either of the components. The phase of $A + C$ is midway between the phases of the two components, or is 45° in advance of C and 45° behind A.

62. When $A+C$ reaches its maximum at b, A has already passed its maximum by 0.00125 second and C has not yet reached its maximum by 0.00125 second = 45° phase = $\pi/4$. Consequently $A + C = 14\ 14 \sin (200\ \pi\ t + \pi/4)$. Again the two armatures may be connected, as shown in Fig. 30, with their planes parallel and their E. M. Fs. in exact opposition. This may be done in two ways; either by employing the regular series connection and reversing the plane of one coil, say, *ab* into the position *ba*, or by retaining the original condition of Fig. 28, and reversing the ends of one coil relatively to the other, so that the two E. M. Fs. are directly opposed. In other words, the reversal of a winding in which an E. M. F. is generated produces thereby a difference of phase of 180°. By either of these methods the E. M. F. of the coil *ab* will be 180° out of phase with the E. M. F. of the coil *cd*. As shown in Fig. 30, *ab* will be 180° in advance of *cd*, because a rotation of half a complete revolution in *cd* would bring it into the position occupied by *ab*. If the sinusoidal E. M. Fs. be plotted at A and C, as shown in Fig. 30, they will be equal and opposite to each other at every instant; consequently, their sum will be zero, as represented at $A+C$.

63. Again, the difference in phase between the component E. M. Fs may be 270°. This may be effected either by employing a difference in plane of 90°, as represented in Fig. 29, and then reversing one winding relatively to the other; or by turning one coil through 270° from the original condition of Fig. 28. The latter condition is represented in Fig. 31, where *ab* is 270° in advance of *cd*, since three-quarters of a revolution would have to be given to *cd* in order

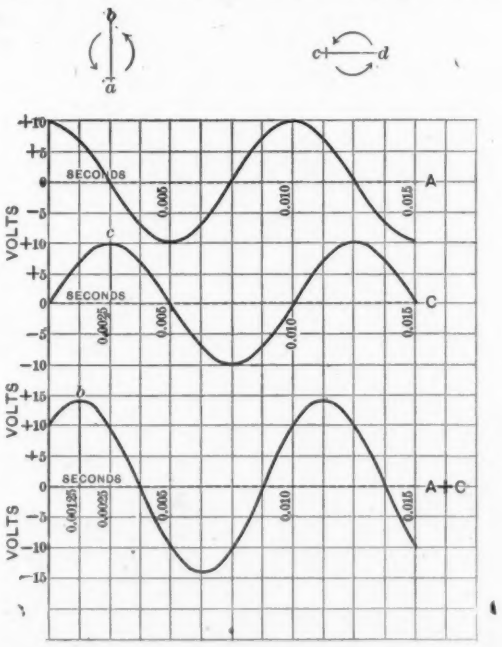


FIG. 29.—SUM OF TWO EQUAL CO-FREQUENCY SINUSOIDAL E. M. FS. DIFFERING IN PHASE BY 90°.

$$10 \sin (200\ \pi\ t + \frac{\pi}{2}) + 10 \sin (200\ \pi\ t) = 14.14 \sin (200\ \pi\ t + \frac{\pi}{4}).$$

to bring it into the position of *ab*. Plotting the sinusoids as before we find that the resultant sum is a sinusoidal E. M. F. having an amplitude of 14.14 volts, and midway in phase between the two components. Thus while $A = 10 \sin (200\ \pi\ t + \frac{3\ \pi}{2})$ volts, $C = 10 \sin (200\ \pi\ t)$ volts and $A + C = 10 \sin (200\ \pi\ t + \frac{3\ \pi}{4})$ volts.

64. In a similar manner, if we plot any two equal co-frequent sinusoidal E. M. Fs. with any other phase difference between them, than those already discussed, we will obtain a single sinusoidal E. M. F. which is their resultant and which has the same frequency, and a phase difference intermediate between the two components. If α be the difference of phase between the two components, then the amplitude of the resultant will be the amplitude of either component, multiplied by twice the cosine of α. Thus if $\alpha = 90° -$ $\pi/2$, the resultant will be $2 \cos 45° = 2 \times 0.707 = 1.414$ times the amplitude of either component.

65. We have hitherto considered the composition in the same series circuit of two co-frequency sinusoidal E. M. Fs. of the same amplitude. If, however, we plot two co-frequency sinusoidal E. M. Fs. of different amplitudes we obtain as their resultant a sinusoidal

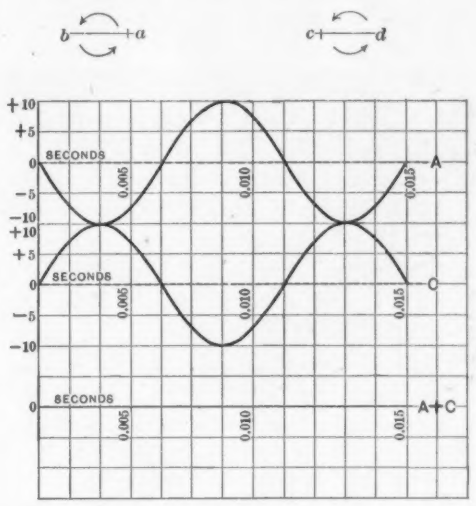


FIG. 30.—SUM OF TWO EQUAL CO-FREQUENCY SINUSOIDAL E. M. FS. DIFFERING IN PHASE BY 180°.

E. M. F. whose amplitude must lie between the sum and difference of the two components inclusive, and whose phase difference must be intermediate between two components, although not generally midway. If the phase difference between them be exactly 0° or

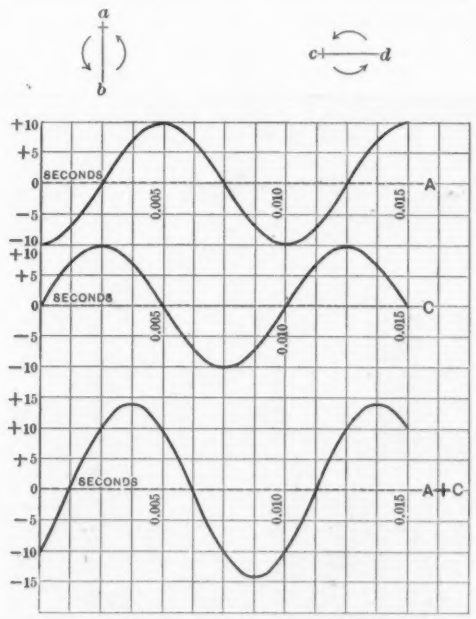


FIG. 31.—SUM OF TWO EQUAL CO-FREQUENCY SINUSOIDAL E. M. FS. DIFFERING IN PHASE BY 270°.

$$10 \sin (200\ \pi\ t + \frac{3\ \pi}{2}) + 10 \sin (200\ \pi\ t) = 14.14 \sin (200\ \pi\ t + \frac{3\ \pi}{4}).$$

180°; in other words, if the two E. M. Fs. are exactly in phase, or exactly out of phase; then, as we have already seen, the resultant E. M. F. will be respectively the sum or the difference of the two components, just as in the case of continuous E. M. Fs.

Poisonous Action of Acetylene.

Our Italian contemporary, *L'Elettricista*, for December, contains an article by Prof. Mosso and Mr. Ottolenghi, in which they describe their researches made to test the poisonous action of acetylene on various animals, such as dogs, birds, frogs and rats, etc. They found it to be a strong poison. A small quantity in the air or inoculated in the blood is followed by death, and even when the animals are resuscitated with fresh air before death, they die afterwards. A mixture of 20 per cent. of acetylene in the air is followed by death in one hour.

Destruction of the Philadelphia Traction Company's Mount Vernon Street Station.

ON the evening of March 3 the fine power station of the Philadelphia Traction Company, at Thirteenth and Mount Vernon Streets, was almost completely destroyed by fire, as was told in THE ELECTRICAL WORLD of last week.

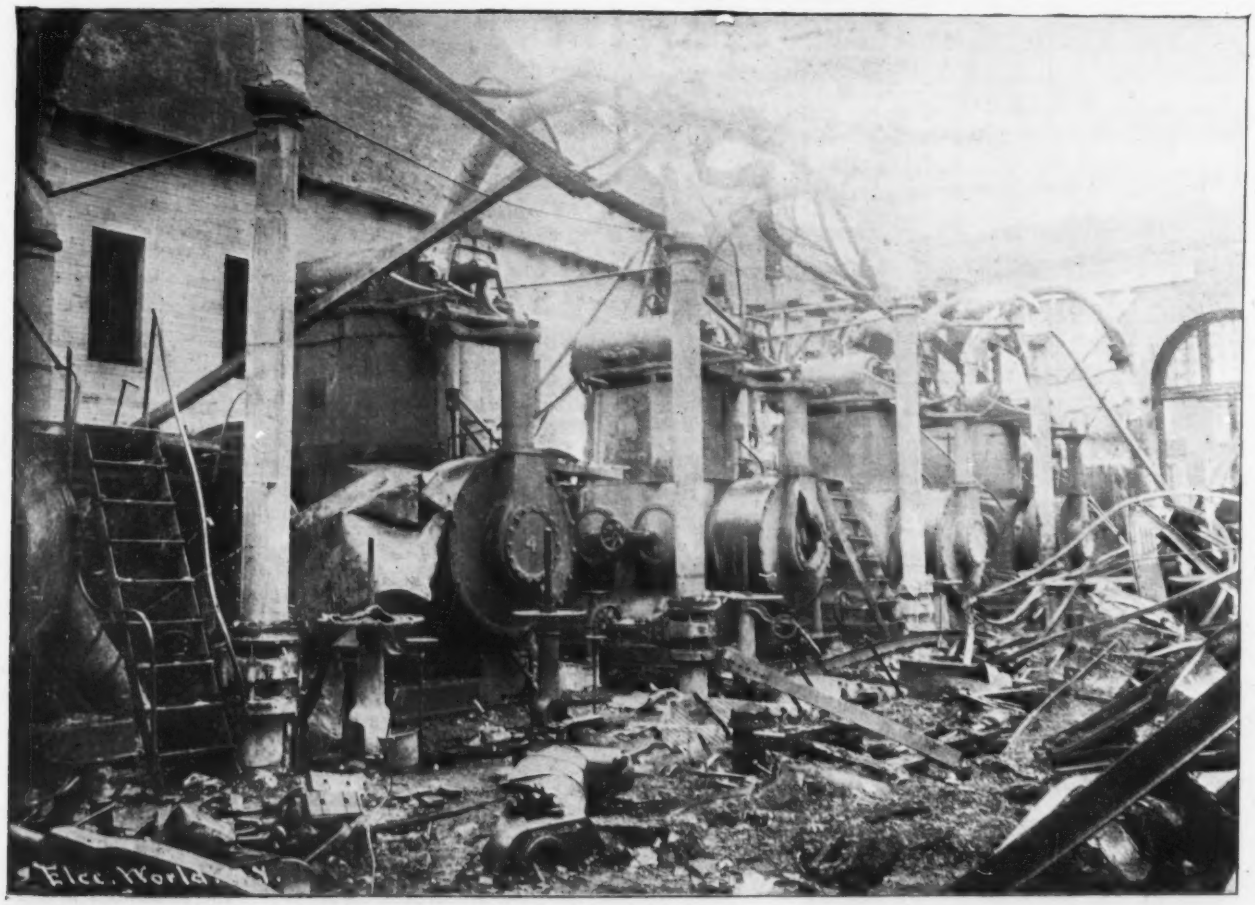
The Mount Vernon Street station, or Station B, was the largest of the eight stations operated by the Union Traction Company, of which the Philadelphia Traction Company is a part. Centrally located between the two rivers which bound Philadelphia on the east and west, and near the business centre of the city, it supplied current to 185 feeder circuits operating the north and south lines from Jackson Street on the south to Richmond, Nicetown and Tioga on the north. In all, more than three hundred cars on the most important lines in the city, derived their power from this station.

The buildings, which were erected during 1893, occupied an area of 171 feet 6 inches along Thirteenth Street by 183 feet along Mount Vernon Street. They were substantially constructed of brick with brown-stone trimmings. The boiler room contained twenty Babcock & Wilcox double deck boilers of 375 horse-power each arranged on opposite sides of a 20-foot passageway.

The engine room, 167 by 98 feet in size, was separated from the boiler-room by a heavy brick fire wall. It contained five direct

NORTHEAST CORNER OF DYNAMO ROOM.

connected sets, each consisting of a Westinghouse compound engine of 600 horse-power and a multipolar Westinghouse generator of 500 kilowatts, and four larger sets, each consisting of a Wetherill-Corliss twin tandem compound engine of 1500 horse-power direct connected to a Westinghouse 1200-kw generator. Each of these units was provided with a 21-foot flywheel weighing



RUINS OF THE FIVE 600-HP GENERATING UNITS.

Four Goubert heaters of 2500 horse-power each were used in connection with four Green economizers, while four Sturtevant blowers furnished artificial draft in the two iron stacks, each of which is 10 feet 6 inches in diameter and 70 feet high.

100,000 pounds. The units were frequently worked to an output of 3000 amperes each at 550 volts. The normal output of the station was about 10,000 amperes under ordinary working conditions.

The switchboard was arranged to supply the 185 feeders radiating

from the station. It extended 96 feet along two of the walls at the southwest corner of the building. The connections were of the usual railway switchboard type, except that a double set of bus-bars permitted a higher voltage to be supplied to those feeders connected to distant points. Weston meters, Hill switches and Westinghouse and Cutter Electrical & Manufacturing Company's supplies were used on the board, all mounted on slate panels set in an iron frame-

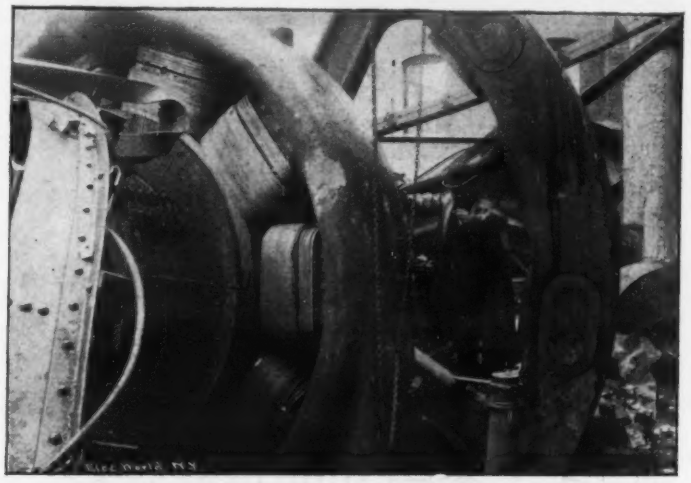
BOILER ROOM.

work. The bus-bars were built up of 3-inch copper rods, 21 feet long.

The floor of the engine room was of 2-inch Georgia pine, extending over a basement of 12 feet depth, in which ran the cables connecting the dynamos with the switchboard and the steam and exhaust piping.

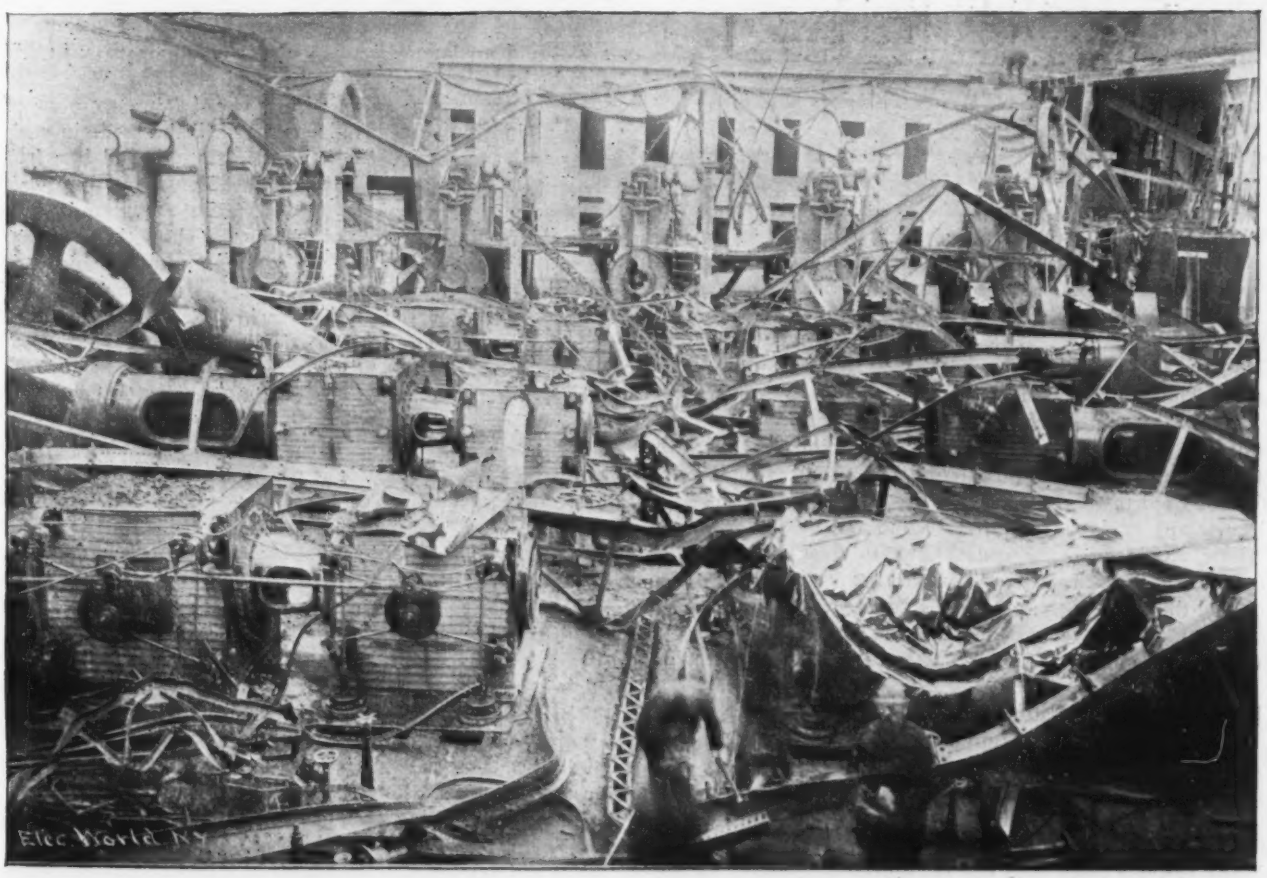
The accident which resulted in the destruction of the plant was over so quickly that accounts of its nature differ. It is believed, however, that it was due to the hand-chain of one of the traveling cranes coming in contact with the positive terminal of one of the large machines and touching the flywheel at the same time. The resulting heavy short-circuit threw sparks and drops of hot metal over and under the oil-soaked pine floor, which burst into flames in a dozen places immediately.

The station men, although drilled to prompt action under emergency, were unable to cope with the flames, which drove them from the building in a few moments. Just as the last had fled, a 14-inch steampipe under the floor near the middle of the line of small generating sets, softened under the heat and burst. The terrific roar of the high-pressure steam from over seven-thousand horse-power of boilers was heard over a large part of the city. Horses of the fire department, ordinarily inured to the noises of a fire, took fright and stampeded through the fleeing crowd that surrounded the building, killing two persons and injuring many others.



WHERE THE SHORT CIRCUIT OCCURRED.

The fire was confined to the engine-room side of the fire wall and the roof of the boiler house. The accompanying illustrations show the condition of the buildings and machinery on the next day better than any possible description. It is estimated that the total loss was about $400,000, which is covered by insurance. None of the machinery can be used again, except the feed-water heaters and one



GENERAL VIEW OF RUINS OF DYNAMO ROOM LOOKING SOUTH.

of the Wetherill-Corliss engines. This went through the fire with no greater loss than its trimmings and part of its valve-gear, and will be in running order before this reaches the reader. The boilers are in good condition, save for the loss of gauges, cocks, valves and other small gear damaged by the falling roof.

As soon as it was possible to enter the ruins the engineering force of the Union Traction Company, under the direction of Mr. Charles Hewitt, chief electrician, and Mr. W. E. Bradley, assistant electrician, went to work to reduce chaos to order and get the cars,

Map of Stations and Part of Union Traction Company.

which had been left standing upon their tracks all over the city, in motion. That they had every line running the next day speaks volumes for their skill and the completeness of the system which permitted the accomplishment of such a feat.

The accompanying diagram of a part of the lines and the stations of the Union Traction Company gives an idea of the situation of affairs. In anticipation of such an accident as has just happened, a complete system of inter-connection had been put in between the stations, and on this occasion proved the great wisdom of such forethought. The cables connecting the Mount Vernon Street station with the others had an aggregate area of nearly ten million circular mils, two of one million each connecting with the Delaware Avenue station, four of one million each to the Beech Street station, three of 650,000 each to the South Street station, and four of half a million circular mils each to the Thirty-second and Dauphin Streets station. The Hutchinson Street station is connected by two cables of 650,000 circular mils each to the Delaware Avenue-Mount Vernon Street line, and the South Street station is connected to the Sutherland Avenue and Thirty-second and Market Streets stations by heavy lines, the latter having an aggregate area of 4,000,000 circular mils.

It will be seen that every station is thus connected to every other, and that the burned station, occupying a central point, was the center of the system of link cables.

The only work necessary to be done to move the cars dependent upon the burned station was to clear the wreckage from the switchboard, take the great copper bus-bars, which were comparatively uninjured, and connect them with the 185 outgoing feeders and the four-link circuits bringing in the current from the other stations.

The work of making the temporary connections was begun before the Fire Department had finished working upon the building. By the morning following every line of railway in the city was in operation, although with a reduced number of cars.

Work was begun immediately upon a new temporary switchboard, and an order was given at once for 165 Cutter circuit-breakers. These were mounted on wooden boards bolted to the skeleton of the former switchboard and protected by the wooden shed shown in one of the accompanying illustrations, which was hastily built against the south and west walls.

The plant will be immediately rebuilt, but it is not as yet decided whether the lines of the old plant will be followed in the new one. It is likely that a considerable change in the arrangement of engines and dynamos will be made.

Interior Conduits.

(*Continued from page 324.*)

Mr. E. G. Bernard, of the E. G. Bernard Company, Troy, N. Y., writes as follows:

"I have long been of the opinion that iron conduits, which have been on the market for some time, are not as practical for general use as they should be. In the first place, with a thoroughly insulated wire, such as the leading rubber-covered wire manufacturers are now putting on the market, it is unnecessary to have any insulation whatever in the conduit, for the following reasons:

"1. The insulation is sufficient to stand a high test immersed in water. Very little water will get into the iron conduits, as a rule. In fact, if properly installed the only water which will ever get in will be from the sweating of the pipes.

"2. When the insulation is finished it can be thoroughly tested and left absolutely clear of any grounds or leaks.

"3. In case of a ground, it is a matter of very little consequence, as all modern plants are equipped with ground detectors, and when a ground is discovered it can very easily be traced, located and the defective wire removed, and a new wire put in its place.

"This is so simply and easily done there is no reason whatever for giving an iron conduit system any anxiety, providing proper means are arranged for testing and the work is installed in a thorough manner. In fact, most of the troubles which have been found in iron conduits up to the present time have been due to the fact that the wire would stick to the insulation of the conduit, and in a good many instances it was impossible to withdraw same, due to this fault, thus practically making the conduit system worthless, as it would no longer be a raceway for conductors, in which they could be installed or withdrawn at will.

"I think there is no question but what in the future we will come to the plain, thin iron gas pipe, which will be made in such a manner as to leave the inside of the pipe smooth and free from burrs. Or, if it is necessary to insulate the pipe from the conductor, it would seem that one of the new insulating compounds or varnishes which are on the market, and which tests show that a single coating placed on metal will stand 7000 volts or more, should certainly be sufficient. These varnishes are flexible, and would allow frequent bending of the pipe without cracking, and the pipe could very easily be treated with a preparation of this kind without greatly increasing the cost.

"It is not necessary in the conduit system to have a pipe with heavy walls and an insulation of corresponding thickness, simply to make it look large and give the purchaser an idea he is getting a quantity for his money. It is preferable to reduce the thickness of pipe and insulation to a minimum, and use quality instead of quantity.

"A point of this kind has just come up, where an architect and an electrical engineer (?) insisted that they did not want the new and improved pipe, because the new pipe is not over ⅛ inch thick in the wall of the pipe, and the insulation not over 3-16 inch. They prefer a heavy, clumsy iron tube, insulated with paper and tar compound, which would melt under very low temperature, to a steel tube which is thick enough to allow heavily loaded trucks of the street to run over it without damaging, and in which the insulation would stand a heat test at least twice as much as the other, and an insulation test of at least three times as much, and they practically stated they were not getting as much for the money, and this apparently was the only reason they could bring forward.

"We will answer your questions as follows:

"1. The insulation should be on the conductor.

"2. When a high grade of insulated conductor is used and properly installed, practically nothing is gained by insulating the conduit.

"3. A thin coating of compound or varnish, which will stand the test, should be sufficient to prevent oxidation and collection of moisture, and also to satisfy those who do not think a plain iron

conduit is sufficient. A properly insulated wire, with a tough braided outer covering, when run in a plain, smooth iron pipe, should not suffer from abrasion by being drawn into the conduit, and we believe there is no trouble in making an iron tube which would be smooth inside.

"4. I think lead-covered wire would cause more trouble and annoyance than would be compensated for by its use.

"5. I do not think any lining is necessary between the wire and the conduit, but if any is used it should be as thin as possible.

"6. I think an absolutely plain iron or steel tubing is sufficient, and should not be coated. If it is coated, some flexible varnish or compound which can be put on as light as possible should be used.

"I understood that Mr. Stieringer, who had charge of installing one of the largest installations at the World's Fair, used plain iron pipe entirely, and never had any trouble in its use. I also believe there are buildings at present in New York, of which the writer has forgotten the names, in which plain iron pipe has been used for a number of years and has given satisfaction. The idea of using a heavy, clumsy, thickly insulated conduit should belong to the eighteenth century, and is certainly not up to the present stage of the art."

Mr. R. H. Pierce, of Pierce & Richardson, consulting and designing engineers, Chicago, Ill., writes that the insulation should be on the conductor most certainly, and that a lining should be such as to prevent oxidation of the tube. Linings similar to those now used undoubtedly prevent mechanical injury to the insulation of the wire, which might result in a bare tube, if the tube were wrought or the joints improperly made. As regards the collection of moisture, either asphaltic paint or enamel lining would be better than the linings now used. If the paint or enamel furnished a smooth surface on the interior of the tube and would not crack off when bending the tube, and if the joints are properly made, there is no reason why we should have abrasion of the insulation. Mr. Pierce would not use bare pipe under any ordinary circumstances, unless it were galvanized. If the pipe were so rough that it appeared necessary to have a lead covering for the protection of the insulation on the conductor, he would then substitute one of the present makes of insulating lined pipes. As for putting a lead covering on wire in an insulating lined pipe, he believes it is foolishness unless there is danger of attack from chemicals which are not ordinarily present. He believes that only in the case of very high voltages is it necessary to have a lining acting as a distance-piece between the insulation on the conductor and the iron pipe. Mr. Pierce believes in using an insulated lined conduit until something is put forward which can be shown to be better. The insulation of the conduit is certainly a safeguard as far as being safer than bare pipe, but he does not think it should be treated as insulation in the proper sense of the term. The insulation of the conductor should be good enough for any voltage that the wire may carry, regardless of the lining in the tube. If the tube has an additional insulating lining, it will make the construction so much the better, and is an advantage, if space permits and its cost does not make it a hardship.

Mr. Pierce states that he has obtained perfectly satisfactory results with plain iron pipe not coated or sealed. "I have not been able to put such construction to a practical time test, but have no doubt that in very large jobs there would be some places in which there would be a great deal of oxidation in plain pipe in time. I would, therefore, say that for general use the pipe ought to be either lined, coated or galvanized, as I do not think it possible at present to get workmen to hermetically seal the pipe.

"In conclusion, I will say that I am, in general construction, specifying the use of iron-armored conduit; that is to say, iron pipe with an insulating lining, in nearly all work except where the wires can be run open. I shall continue this practice until the trade furnishes something better."

One of the leading Wire manufacturers writes that it is to be recommended that the wire should be depended upon for the insulation and the standard of quality of the insulation raised to such a point, and maintained that it can be relied upon under all conditions.

Messrs. F. J. Dommerque and M. H. Bentley, of the Chicago Telephone Company, write as follows:

"First of all, the best class of insulated wire only should be used for interior conduits, the quality of insulation not to be sacrificed in any degree. Undertakers of this class of insulation should employ only conscientious and able workmen to install the wiring. It would appear to be best not to depend on the conduit or tube for insulation, but to install the wire in the same manner as in other methods of construction. The gain, nevertheless, of using an insulating lined tube is manifold:

"First, it affords mechanical protection; second, provides extra insulation, which cannot be too great; third, the chance for abrasion is less in a tube having a smooth inside covering than in a bare iron tube.

"A thin coating of asphaltic paint or enamel would certainly prevent oxidation and condensation of moisture in a measure.

"The introduction of moisture depends primarily on the care taken in making joints in the conduit. Such a lining would prevent abrasion to a certain extent, but would not prevent abrasion upon the burrs left, if the pipes were not carefully reamed out where cut. All burrs and inequalities should be removed before paint or enamel is applied. An enamel similar to the one used for cooking utensils would be an ideal lining for conduits—in such cases where the pipe could be cut to length before being finished.

"An extra protective covering on the insulation of the wire would necessarily render the wire safer against mechanical injuries, but would at the same time decrease the flexibility of the wire. The ideal conduit would prevent all possibility of abrasion of the wire, and therefore an extra covering on the wire is considered unnecessary. Lead covering on the wire to be drawn into tubing is only necessary where the wire cannot be protected otherwise against moisture and corrosion. The lead covering that could be supplied on the smaller sizes of wire without increasing the diameter over all to a prohibitive figure would be weak mechanically. Danger of the lead covering flowing upon vertical runs and where weight of great length is carried must be taken into consideration.

"The best method would be to make the joints in the conduit tight, and in this way keep the moisture out.

"The selection of high-grade insulated wire, and the care taken in making the joints tight, does away with the necessity for distance-pieces. A coated tube, or better an enameled tube, is preferable to a bare tube, but the tube must be carefully smoothed inside before applying paint or enamel, this smoothing to consist, not of a casual inspection with removal of apparent irregularities, but a reamer or equivalent tool should be used upon every inch of length of the conduit."

Moving the Field Frames of Dire t-Connected Units.

To the Editor of The Electrical World:

Sir:—I notice in your issue of February 27, on page 296, a description is given of a method of moving the field frame of a direct-connected generator parallel with the shaft on case-iron guides secured to the foundation in such a manner as to allow the free inspection of the armature, and that the statement is made that "it is the invention of Professor Sidney H. Short, of Cleveland, Ohio." If this device can be called an invention I beg to point out the fact that the same arrangement was used on one of the direct-connected generators of the Intramural Power Station at the World's Fair, put in by the General Electric Company, and a further improvement of the device was put in operation by me in the plant of the Fort Dodge Light Power Company of Fort Dodge, Iowa, July 1, 1895. This was fully described in a paper read before the Northwestern Electrical Association, January 16, 1896, by Mr. E. R. Cunningham, superintendent of the Fort Dodge plant, and published in THE ELECTRICAL WORLD, January 25, 1896. So far as I am concerned, I think that the engineers of the General Electric Company are entitled to whatever originality there is to the device, although it is possible it was used by others before them. It is a fact, however, that it was used by them and myself some time before it was brought out by Professor Short.

A better plan, in my judgment, to accomplish the same purpose is to divide the field of a generaotr on a vertical plane parallel with the shaft, so that each half can be moved horizontally at right angles to the shaft on a suitable cast-iron base, as originated, I believe by the Westinghouse Electric & Manufacturing Company. I have used this device in the plant of the Chicago Board of Trade with Westinghouse generaotrs, and specified it for the plant of the Englewood & Chicago Electric Railway Company, in which Walker generators are used, designed by Professor Short. This arrangement takes no additional length of shafting, no extra floor space, and has all the advantages claimed for the first arrangement.

B. J. ARNOLD.

CHICAGO, ILL.

DIGEST OF CURRENT TECHNICAL ELECTRICAL ARTICLES COMPILED FROM FOREIGN AND AMERICAN JOURNALS

BY

CARL HERING

DYNAMOS, MOTORS AND TRANSFORMERS.

High Frequency Generator. TESLA system. *Elec. Eng.*, Mar. 3.—A brief illustrated description of a new system of causing the breaks in the circuit. In the usual system a spark-gap was used, but in the present one there is a combination of two condensers with a circuit controller operated by a motor so as to charge and discharge the condensers alternately, one of them discharging while the other is being charged; this is done by a cylindrical commutator on which bear three brushes, two of which are permanently connected to the condensers and to sliding rings, each of which is connected to every fourth commutator bar, every alternate bar being blank, while the third brush slides over the commutator bars, being thereby connected alternately to the other two brushes, passing over a blank block between each two live sections; the third brush is connected to the main circuit through a primary coil of a transformer, the secondary of which is the source of the high frequency currents.

Care of Electrical Machinery. BAXTER. *Power*, March.—A continuation of his series of elementary articles; in the present one he discusses the subject of magnetism and the magnetic fields in dynamos.

LIGHTS AND LIGHTING.

Luminous Efficiency of the Arc. BLONDEL. *L'Eclairage Elec.*, Feb. 13.—The beginning of a reprint of his paper read at the Carthage Congress of the French Association for the Advancement of Sciences; the results of numerous extended tests are given in tables and curves. This paper refers to the continuous current arc and is the one referred to in his supplementary paper on the alternating-current arc which was published in THE ELECTRICAL WORLD beginning Feb. 13, p. 232.

Vacuum Tube Lighting. EDSON. *West. Elec.*, Mar. 6.—A reprint, apparently in full, of a recent paper read before the Chicago Electrical Association; it is largely general in character and includes criticisms of some of the proposed methods. He calls attention to the fact that by far the largest loss of efficiency in lighting is in the lamp itself, the total efficiency from the heat units of the coal to the radiant light in an incandescent electric lamp being only about 1.5 per cent.; a table is given showing the light efficiency of a number of illuminants; that of the incandescent lamp is given as 5 per cent., of the arc lamp 16 per cent. and of the Geissler tube 32 per cent.; the composition of some of the common lights and of reflected light is given in tables. He believes the problem is not so much to obtain a great quantity of light, but to obtain it of the proper quality, and in this respect incandescent carbon does not seem susceptible of any great improvement; he enumerates the several methods for producing light by high frequency impulses; the incandescence of solids in a vacuum is out of the question unless it may be by means of new compounds produced by the electric furnace; phosphorescence implies greater economy on account of the lower temperature, but most phosphorescent substances lose their luminous power when subjected to too high a temperature, and there is also a maximum potential which should not be exceeded; the luminosity of a gas in a tube at ordinary pressure in connection with high frequency currents may promise much, but there are many difficulties; to obtain intense luminous effects in a gas requires either high potentials or high frequencies; what is required is some means of giving the atoms "a quick blow"; the Moore system is briefly described and its defects pointed out. Much quantitative information on the subject of vacuum tube lighting is wanting; he thinks his own work in this direction may yield some quantitative results; the great objection to the system is the high potential which has to be used. In conclusion, he outlines briefly a system which he says may seem visionary to some; it seems to be based on the use of a substance which will emit light when subjected to high frequency, low potential currents, and which is mixed with the pigments used in wall-paper, the sides of the rooms being coated with it; it is to be invisible by sun-light, allowing the true color of the pigment to show; the amount of light emitted is to be 1 cp per sq. ft.; some of the objections to such a system have been removed and there is some hope of obtaining commercial results.

Whistling Arcs. BAIN. *West. Elec.*, Mar. 6.—A long article in which he describes a peculiar experience with some arc light circuits in Chicago, and after describing at length many unsuccessful attempts to find a remedy, he explains briefly the final successful one. The series system of arc lighting with continuous current was used, and the leads consisted of lead covered, rubber, wire cables, run underground in wooden ducts; the phenomenon was a loud, harsh, whistling noise produced in the lamps as soon as the arcs were struck; it was loud enough to be heard two blocks off; the lamps did not whistle all the time, but apparently only when the arc was long and flaming; the telephone system in the whole of that part of Chicago was rendered almost inoperative while the lamps were burning; the note was independent of the vibrations produced by the commutator as well as of the lamp mechanism; the whistling seemed to travel from point to point along the circuit, about one-third of the lamps being noisy at the same time. The remedy consisted in connecting together, with a low resistance wire and soldered joints, the outside lead coverings of the underground wires; after this was done there was absolutely no noise; he believes the whistling was caused by electrostatic induction; the capacity of the cable governed the pitch of the note; the phenomenon is entirely independent of the type of dynamo or lamp; it seems to be caused by the cable having a high dielectric and large static capacity; it is independent to a very great degree of the insulation resistance of the circuit as a whole, to the ground; the pitch of the note is determined by the average length of the lead sections left unconnected; atmospheric conditions do not in the least affect it.

POWER.

Application of the Ferraris-Arno System of Distribution.—L'Ellettricista, February.—A short note stating that an application of this system has been made in a printing establishment in Innsbruck, in which power for motors is distributed by alternating currents.

Mother Lode Power Plant.—Eng. & Min. Jour., Mar. 6.—A note on the large Blue Lakes power plant, California, which is in course of construction; the system will embrace thirty-three miles of mines; the preliminary installations will consist of two 750-kw two-phase generators; very little is said about the electrical portion.

Gas Engines for Electric Lighting.—Prog. Age, Mar. 1.—A reprint of a short article from the *Mechanical World* (London) showing why the use of gas engines for electric lighting has not been altogether satisfactory and giving briefly some data for some of the newer plants.

Mining Installation. SPRAGUE. *Elec. Rev*, Mar. 10.—An illustrated description of the central electrical station of the Davis Coal & Coke Co., in West Virginia, the first in that region to adopt electricity in connection with mining operations.

Power Plants in Department Stores—Power. March.—A well-illustrated description of the large power plants in the two Siegel-Cooper stores in New York and Chicago.

TRACTION.

Electric Traction on a Steam Road in Belgium. PIERARD. *L'Elec.*, Feb. 20.—A short article describing briefly an installation which is to be made on the occasion of the coming exhibition at Brussels, in which electric traction is to be used in connection with steam traction on the steam line from Brussels to Tervuereu, a distance of nine miles; the maximum grade is 1.6 per cent.; both steam and electric traction will be used; there will be five motor cars running at a speed of 18 miles an hour on the steepest grades and 30 miles on the other portions; they will contain eighty passengers each; there will be two motors of 75-kw each, mounted directly on the axles without gearing; their weight will be eight to nine tons; the car will weigh twenty tons and will be driven with accumulators weighing twelve tons; the schedule time will be 22 minutes for the express trains and 32 for the accommodation trains; there will be three Julien and two Tudor batteries of 264 cells each, besides eight reserve cells; the Julien cells will make three trips with one charge and the Tudor one trip; (their relative weights are not given nor is it stated which of the sets weigh twelve tons); the former will require six hours for the charge and the latter, one; the results of the tests of one of these batteries is given briefly. The object is not to make a test of accumulator traction, but to compare different forms of motors, the accumulators being merely used incidentally; the Jaspar, Pieper, Schuckert and Thury are the motors to be tested; they will be compound wound with a long shunt, the series winding forming part of the starting resistance; with 500 volts, the two motors in series are to have a speed of 116 revolutions and are to take 150 amperes, the shunt winding alone being used and the efficiency in that case being 75 per cent.; in parallel with the shunt winding alone the total current is to be 150 amperes, the speed 231 revolutions and the efficiency 80 per cent.; it is thought that the cars will be running by the beginning of June.

Budapest Underground Electric Railway. MONTIER. *L'Eclairage Elec.*, Feb. 13.—The beginning of an article on the electric railways in that city, the present portion being devoted to a well-illustrated description of the underground tunnel railway recently completed in that city.

Application of Accumulators in Power Railway Houses. SCHOOP. *Zeit. für Elek.*, Feb. 15.—A report of a recent lecture describing the various systems and showing the advantages in using accumulators, especially in small installations in which there is a water-power whose total energy during the twenty-four hours is sufficient while the power at any one time is not; figures for such a case are given, from which it appears that the accumulator which he represents, having a capacity of 320-hp hours at 500 volts, will cost about $8000 ready for use, and which the makers agree to maintain at 4 per cent. per annum. In such an installation the battery must be connected in parallel with the line and with the dynamo; a switch will then be necessary in the dynamo circuit for throwing the dynamo in and out; such a switch is described and is operated by means of a pivoted, permanent magnet operated on by an electromagnet connected across the switch and having a high resistance; when the voltage of the dynamo is the proper amount no current will flow through this winding, the switch will thereby be closed; a series magnet, through which this main current then flows, holds the switch in place; as the reverse current must first pass through the zero

value, the switch will break the circuit. When the resistance of a battery is not negligible, additional apparatus is required; in one method there are the usual number of extra regulating cells; in practice, however, the resistance of a battery may generally be neglected, for when it is being charged and discharged continuously by small amounts the difference in voltage will not be more than 5 per cent. as long as the charge of the battery is about three-quarters to four-fifths of the full capacity. Another arrangement is shown when it is desired to keep the battery at its full capacity; this is the arrangement used at Zurich (which we understand has now been abandoned), and consists in the use of an extra booster dynamo; this has been introduced in a number of places and is said to be very satisfactory; (the description unfortunately is not very clear). The Siemens system is also described and illustrated; it seems to consist of the insertion of a compound dynamo in the battery circuit, the shunt winding of which is connected to the terminals of the battery, while the line current passes through the series winding, but in the opposite direction; when more current is required by the line the E. M. F. is thereby raised and vice versa, the battery being charged when the line current is small; whether this is in use in practice is not known to the author. An illustration of the accumulator is given.

Comparative Economy in Electric Railway Operation. DAVIS. *Eng. Mag.*, March.—A short article discussing the subject of the concentration of power, compounding and condensing engines; he calls attention to the enormous amount of money spent on 10,000 to 20,000 hp plants concentrated at one point which do not produce a horse-power cheaper than smaller stations, cost more per horse-power and require large investments for feeder systems. Omitting exceptionable cases the cost of operating an electric railway under ordinary conditions, he states, is about 13 cents a car mile which, with coal at $3.00 per gross ton, is divided as follows: Power, 11.5 per cent.; cars, 19 per cent.; track and line, 27 per cent.; car labor, 42.5 per cent.; the coal costs about 5.75 per cent. of the total expenses per car mile; he states that a maximum saving of 46 per cent. of the coal, or 2.6 per cent. of the total cost per car mile, could be made by the use of the most economical plants as compared with single expansion. It is generally conceded that above 5000 horse-power there is usually no material saving in further concentration of the power, and that compound condensing plants do not show enough saving in small stations to more than balance the interest of the greater cost. A table is given comparing the economy in two roads, and showing a lower cost of operating per car mile due to a better equipment; two large tables are given, containing information gathered from a large number of roads three years ago, referring chiefly to the coal consumption.

Overhead Construction for Suburban Lines. MACARTNEY. *St. Ry. Jour.*, March.—A short article on estimating the cost of overhead work, giving the figures of some recent estimates for a plain but durable construction, under the conditions existing in most of the Eastern and Middle States.

Power Station Records. MOORE. *St. Ry. Jour.*, March.—The report of the power-house record of the Trenton Railway Company for the past year; the average cost for wages, fuel and repairs was 1.14 cents per car mile.

Syracuse.—St. Ry. Jour., March.—A long, well-illustrated description of the system of street railways in that city.

Chicago.—St. Ry. Jour., March.—A long, well-illustrated description of the new power station of the Chicago City Railway.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Equalizing Connections for Compound Wound Dynamos in Multiple KELLER. *Jour. Frank. Inst.*, March.—A reprint of a recent paper read before the Electrical Section of that Institute. The larger part is devoted to a detailed explanation of the usual system of equalizing, illustrating it by means of a mechanical analogy, and discussing in detail the action of the equalizing bar; he shows that this equalizing bar effectually prevents a reversal of polarity, but only tends to equalize the currents in the series windings, the tendency being more nearly realized the less the resistance of the equalizing wires. He discusses analytically the distribution of the currents for given resistances and for varying values of the E. M. F., and applies the results to a case in actual practice showing that a difference of five volts in the E. M. F. of two machines caused a flow of current in one armature four times as great as that in the other, and that the equalizer bar made the currents in the two series windings nearly equal, within 3.5 per cent. In conclusion he suggests a new arrangement, in which the drop of potential in the equalizer is divided equally among the machines as a result of which the currents in the series windings of all the machines are equal under all conditions; this is accomplished by connecting the beginnings of all the series coils to an extra bus or equalizing bar to which is connected also one brush of each machine, instead of connecting the series windings direct to the brushes and the junctions of these to the equalizing bus-bar, as in the usual method; the currents in the series coils of the machines will then at all times be proportional to the capacities of the machines provided the resistances are proportioned in such a way that the drop of potential from the brushes of all of the machines to the bus-bars will be the same at full load. When an additional machine is then thrown on, the single pole switch connecting the series coils with one of the bus-bars is first closed, the other end of the series coil being permanently connected with the equalizing bar; a current will then flow in the series coil; the shunt circuit is then adjusted for the desired E. M. F., after which the main switch is closed. This system does not equalize the currents in the armatures, but it equalizes those in the series coils, an effect which is only partly accomplished in the first-mentioned system; it is applicable to any number of generators of equal or of different capacities; it has the disadvantages that it necessitates an additional conductor from the dynamo to the switchboard, the full current passing through the conductors which replace the equalizer; the first cost is somewhat increased, as is also the energy loss, which latter would be sufficient to preclude the application of the method in very large installations in which there is a great distance between the dynamos and the switchboard, but in smaller installations the increased first cost is inappreciable.

Municipal Plants. WINCHESTER. *Elec. Eng.*, Mar. 3.—A communication referring to the editorial comments of that journal which were noticed in the *Digest*, Feb. 27. He expresses disappointment with the intention of that editorial and with the selection of articles in that issue, on the ground that the subject was not treated with impartiality; the articles referred to unfavorable extremes and exceptionable conditions, and did not throw any light on existing successful municipal plants; there are many highly successful municipal plants in operation to-day and a statement to the contrary is therefore not in accordance with facts; the list of plants contained in his report was made up of good and bad, without partiality, and a careful study of this list does not bear out the statements in that editorial. The field of the municipal plant is to offer relief to places which are burdened with cheap plants owned by speculative private corporations, who supply miserable service at maximum rates. He questions the reliability of the figures in the report concerning Utica; the data is most incomplete and the figures in that list concerning the South Norwalk municipal plant, are all wrong; the figures, including interest, depreciation and all operating expenses concerning this plant are given. He desires to see this question treated for once without partiality; the opponents to municipal plants should prove their statements by facts that will stand investigation.

Protection of High Tension Lines from Atmospheric Electricity. CHAVANNES. *West. Elec.*, Mar. 6.—A reprint of the conclusions of his report to the Geneva Congress, which was abstracted in the *Digest*, Sept. 12.

Central Station Costs.—Elec. Eng., Mar. 3; reprinted from the *Sibley Jour.*—A tabulated list of the costs in detail, for one year, ending April 1, 1896, in a large, modern Edison lighting plant.

Facts Relating to Gas and Electricity. SEAMON. *Prog. Age*, Mar. 1.—A reprint of a recent paper read before the meeting of the Ohio Gas Lighting Association. He compares central stations with gas plants to the disadvantage of the former and praises the management of gas interests for having held their own in this competition. It is followed by quite a long discussion.

ELECTRO-PHYSICS AND MAGNETISM.

Ferranti Effect of Transformers. GRASSI. *L'Elettricista*, January and February.—When a condenser shunts the secondary of a transformer the co-efficient of transformation is altered; many hypotheses and theories have been offered to explain this result; the generally accepted explanation associated the result with the magnetic leakage, which is variable; the present writer gives a complete mathematical theory of the phenomenon, showing that no special assumption regarding the behavior of the magnetic lines is necessary and that the Ferranti effect is the natural result of the conductance and the magnetic reluctance of transformers; the paper is mathematical in character.

Electric Resonance and Consonance. FELDMAN. *Elek. Zeit.*, Feb. 25.—The conclusion of his article, the first portion of which was abstracted in the *Digest* last week. He discusses the proof of the theory by quoting from an article by Chapman (see ELECTRICAL WORLD, Vol. 27, 1896, p. 704). This is followed by a brief reference to the application of the theory. His discussion of the phenomenon of consonance throws considerable light on phenomena which formerly had been considered as resonance; the well-known Ferranti effect and the phenomenon described by Neustadt showing an increased voltage when cables are connected and disconnected, are really consonance phenomena, as they also take place with changes of the frequency, and are, therefore, not based on the phenomena of synchronism, as is required for pure resonance.

Influence of the Electric State of the Surface of a Liquid on the Heat of Vaporization. FONTAINE. *L'Eclairage Elec.*, Feb. 20; abstracted from the *Jour. de Physique*, January, 1896.—He shows that the heat of vaporization of a liquid is a function of the electrical condition of its surface.

New Kind of Cathode Rays. GOLDSTEIN. *L'Eclairage Elec.*, Feb. 20.—A long abstract of an article in which he describes experiments made to study the space immediately next to the cathode in a rarified tube, which space has not been investigated like those beyond it.

Molecular Conductivity of Dilute Solutions of Salts. JOUBIN. *L'Eclairage Elec.*, Feb. 13.—An abstract of an Academy paper in the *Comptes Rendus* 124, p. 228.

Generalization of Electromagnetic Formulas. VASCHY. *L'Eclairage Elec.*, Feb. 13.—An abstract of a mathematical paper from the *Comptes Rendus* 124, p. 226.

Absorption of Electric Waves by a Terminal Bridge. BARTON and BRYAN. *Proc.*, Lond. *Phys. Soc.*, February.—The beginning of a reprint in full of the paper noticed in the *Digest* Dec. 12.

Variations of Energy. VASCHY. *L'Eclairage Elec.*, Feb. 20.—An abstract of an Academy paper of a theoretical nature, from the *Comptes Rendus* 124, p. 284.

Electrical Conductivity of Aluminum. RICHARDS and THOMSON. *Jour. Frank. Inst.*, March.—A short article in which they give the results of their recent determination of the electrical conductivity of this metal, which was furnished by the Pittsburg Reduction Company; the conductivity was determined in absolute measurement, thus requiring no reference to any other metal as a standard; a certified standard resistance coil of one international ohm was used, the possible error being not over 0.02 per cent. The results of 5 different specimens of various degrees of purity are given in a table, together with the exact analysis of each specimen; the figures for the purest are as follows: 99.66 per cent. of aluminum, the impurity being iron, silicon and sodium; the resistance

at O°C of one meter by one mm in diameter, was 0.031245 for hard wire; this corresponds to a specific resistance at O° in absolute units of 2453.7 for hard; and 2432.2 for annealed aluminum; the resistance of the less pure specimens increases, though not in the same proportion as the amount of aluminum is less; between 27° and 0°C the temperature co-efficient was 0.00392 per degree; the purer the metal the greater its temperature co-efficient. Another table is given in which these values are compared with those obtained by Scott, relative to copper; these values depend on what is assumed as the resistance of copper; taking for this value 1580, the resistance above given for the purest specimen, corresponds to 65 for the soft and 64.4 for the hard aluminum, when compared to copper taken as 100; the temperature co-efficient obtained by Scott is also given and is slightly lower. A comparison is also made with the figures obtained by Charpentier-Page, which are assumed to be those for the best European aluminum, which averages 99 per cent. pure; the results agree closely with those of the present authors showing almost 1 per cent. greater conductivity for the annealed than for the hard-drawn wire. Other results are also given. Their final conclusion is that the conductivity of hard-drawn commercial aluminum is strongly affected by impurities, and that it is 55.0 (relative to copper) for 98.5 per cent. pure aluminum, 59.0 for 99.0 per cent., 61.0 for 99.5 per cent., 63.0 to 64.0 for 99.75 per cent., and probably 66 to 67 for 100 per cent. pure.

Action of Röntgen Rays on Vision. Kolle. *Elec. Eng.*, Mar. 3.—A note stating that of 7 persons with amaurosis subjected to the Rontgen rays, 6 observed a peculiar shooting-star light.

Evolution of the X-Rays. Cornu. *Elec. Eng.*, Mar. 3.—A reprint in abstract of the address noticed in the *Digest*, Jan. 23.

X-Ray Apparatus and Methods. Willyoung and Sayen. *Jour. Frank. Inst.*, March.—A reprint in full of the paper which was noticed in the *Digest*, Feb. 6 and 13.

Radiation. Dorman. *Elty*, Mar. 3.—The beginning of a reprint of the address noticed in the *Digest*, Feb. 6.

ELECTRO-CHEMISTRY AND BATTERIES.

Reactions in the Carbon Cell. Liebenow and Strasser. *Zeit. f. Elektrochemie*, Feb. 20.—A long article accompanied by a large number of curves giving the results of extended researches to find out what the reactions are in a cell in which the electrodes are carbon and a metal in fused potassium hydrate (known here as the Jacques battery). Up to the present time little has been known concerning the true reaction; Reed see The Electrical World, July 25, p. 98, and Aug. 8, p. 159) made some interesting statements, but they claim that his explanation of the thermotropic nature of the action are not satisfactory; they repeated Reed's experiments and obtained similar results; the duration of the period of high voltage varied greatly, and after this period had been reached once it was never possible to bring it about a second time, even if the electrode was scraped and cleaned or replaced by a new one, or if water was added or the electrolyte cooled and fused again, the voltage continued to remain small; an experiment was tried with two bent tubes, through one of which a current of air was passed; voltages up to one volt were noticed, though seldom, but after the subsequent diminution of the voltage had taken place no amount of heat would again cause such a high voltage; it appeared that the phenomenon was connected with a change in the fused electrolyte; a systematic research was then made, the results of which are given in detail. The method used was to measure the potential difference between the electrode and the electrolyte by using an Ostwald standard electrode; this was inserted only for a moment while the reading was taken; the temperature of the fused electrolyte was measured with a pyrometer. For iron in an iron crucible, and fused potassium hydrate, the potential between the iron electrode and the electrolyte is given in a curve for periods of time up to two hours; the curve of the corresponding temperature is also given; the standard electrode consisted of mercury; the voltage at first fell slightly, hydrogen being freely developed on the iron rod, the iron therefore behaving like zinc; this was for the first forty minutes, during which time the liquid had a greenish color and the temperature was 524°, but the color then suddenly changed to a dark brown, the temperature falling slightly during the same interval of about ten minutes, although heat was being applied continuously (thus showing that a heat-consuming reaction was taking place), and at the same time the voltage increased very rapidly by as much as 1.17 volt, after which it remained practically constant for the remaining hour, even though the flame had been extinguished; from this it follows that the iron assumes two different voltages differing by more than one volt from each other; this property of iron is well known, as shown for instance when iron is placed in concentrated nitric acid; as long as the alkali dissolves the iron, the latter is strongly negative, but when the color changes to brown there is no longer a dissolving action and the iron becomes passive; it is the oxidizing action of the electrolyte which makes the iron passive; this explains Reed's observations; the oxygen of the air brings about the oxidation of the iron dissolved in the alkali, and there is therefore an oxidizing action on the surface, the rod becoming passive; the difference of potential between the iron crucible and the rod will be about one volt until the alkali contains more or less oxygen down to the very bottom of the crucible, when the latter will become passive, after which no potential difference will exist between the two; sodium hydrate gave quite similar results, with the difference that the dependence of the voltage of the iron on the temperature is much greater, while it is being dissolved. Nickel in a nickel crucible gave similar results; the voltage of the passive nickel depends very largely on the temperature; silver in a silver crucible was also tried, and the results, which are slightly different, are given. The measurements with carbon showed that it behaved quite differently from the other three metals; it has not the property of becoming passive like the other metals, and therefore resembles the metals while they are being dissolved, whether the alkali is fresh or has taken the dark-brown color; the carbon is dissolved slowly converting the alkali into a carbonate; the effect of the temperature on the voltage of the carbon (against mercury) is very great; measurements with a carbon crucible showed variations which may have been due to impurities; there seems to be an effect due to the water in the electrolyte. The voltages for 500° compared with a mercury electrode as a standard are given in a table, from which it follows that with the aid of a fused electrolyte, in which the metals become passive, a cell can be constructed by the insertion of carbon into the liquid, which at about 500°C generates about one volt; this is the cell as made by Jacques. A cell was made of fused potassium hydrate in an iron crucible into which a carbon and an iron rod were both inserted; the temperature and the difference of potential between the iron and the carbon rods were measured and are given in curves; at first the voltage is low and reversed, but at the moment when the color of the liquid changes, the voltage rises to 0.8, which for an increased temperature may be increased to nearly one volt; the action is quite similar in a nickel crucible with a carbon and a nickel rod. They then show that the property of the electrolyte to make metals passive is due to its absorption of oxygen; an experiment was made with a closed vessel arranged so that gases can be passed over the surface of the liquid; curves showing the voltages, and the temperatures are given for illuminating gas, oxygen, air and hydrogen; with illuminating gas the iron did not become passive, although the experiment was continued for four hours; with air, however, the passive condition was reached after a short time; air and oxygen brought about the passive condition, but hydrogen and its compounds brought about the active condition again; they conclude from this that it is the dissolved metals in a highly oxidized condition, which give to the liquid the property of making the metals passive. Experiments were then made with a cell while it generated current, and it was shown that the metal electrode was easily polarized, but the carbon was not; this is shown in curves; the iron, however, may be depolarized by passing sufficient air through the cell, as is done by Jacques; this air does not, therefore, as Reed supposes, serve only to cool one of the electrodes, but is really a depolarizing oxidizer. Their conclusions are that the actions in the carbon cell are based partly on the fact that the carbon is dissolved, like zinc, and therefore generates positive ions and partly on the phenomenon of the passive state of iron and some other metals. According to the theory of ions this passive condition is caused by the appearance, on the metal electrode, of more or less soluble negative ions rich in oxygen, which are similar to the peroxide of lead ions that in their opinion take such an important part in the reactions in the lead accumulator.

Electricity Direct from Fuel. Weber. *Elek. Zeit.*, Feb. 25.—A reprint of a short paper giving a summary of the publications on this subject; it is brief and not quite complete; it seems to contain nothing new; brief descriptions are given of the researches of Jablochkoff, Jacques, Coehn, Faure and Borchers. He shows the desirability of more energetic research in this field in order to find out whether there is any possibility of any of these processes becoming practical.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Alternating Current Measuring Apparatus. Armagnat. *L'Eclairage Elec.*, Feb. 13 and 20.—A continuation of his long serial on measuring instruments; in the issue of Feb. 13 he discusses resistance coils, ampere and volt meters, showing, in connection with the former, the capacity effect of bifilar coils. In the issue of Feb. 20 he discusses watt meters and the testing of alternating current apparatus.

Dimensions of Electric and Magnetic Quantities. Joubin. *L'Eclairage Elec.*, Feb. 20; abstracted briefly from the *Jour. de Physique*, February.—He recently showed (see *Digest*, Oct. 24) that the dimensions of electric and magnetic quantities can be completely determined as functions of the fundamental rational mechanical units, by admitting a certain postulate; he now shows that these formulas are correct without any restriction.

Method of Measuring Electrolytic Conductivity by Continuous Current. Stroud and Henderson. *Proc.*, Lond. *Phys. Soc.*, February.—A reprint of the complete paper noticed in the *Digest*, Nov. 28, together with an abstract of the discussion.

Automatic Interrupter for Induction Coils. Sayen and Willyoung. *Jour. Frank. Inst.*, March.—A reprint of a short paper recently read at the electrical section of that Institute. They point out the faults of the usual Apps vibrator and show that the circuit ought to be broken with great suddenness, which is evidently not possible with a heavy hammer-head, as in that vibrator, which requires an appreciable time to attain any great velocity, while the current is reduced to nearly zero by the very first movement. In their improved form, the hammer is not directly connected with the break; when attracted by the coil it moves freely for some distance, during which it attains a high velocity of motion, at which time it strikes a yoke, thereby breaking the circuit; the suddenness of this break is much greater than with the usual form; there is then practically no spark; after a continuous run of from 30 to 40 minutes there is no appreciable rise in temperature at the contact points; the same coil operated by a new vibrator requires not over one-half the current to produce equally good results; this arrangement enables a coil to be used directly with a 110-volts circuit; the secondary sparks obtained are longer.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Inventor of the Telephone.—L'Elec., Feb. 20.—A note stating that it is now claimed that an Italian inventor, named Manzetti, who died in 1887, invented a telephone almost exactly like the one of Bell.

Disturbances in Telephone Lines. Muench and Pierard. *L'Eclairage Elec.*, Feb. 20.—Two short articles discussing the suggestion made some time ago by Mueller, which has been referred to a number of times in these columns, and in which he suggests a remedy. Pierard considers that the theory of this method is not correct, and until there are further

indisputable facts he will continue to believe that the origin of the trouble is electrostatic.

Telephone Service without a Calling Battery at the Subscriber's End. RITTER. *Elek. Zeit.*, Feb. 25.—A continuation of his article (see *Digest*, last week). He describes the installation with single-wire circuits; the article is to be concluded.

MISCELLANEOUS.

Prizes.—Elek. Zeit., Feb. 25—An announcement that a German electrical society has offered a prize for papers on two subjects; one on researches concerning the protection of electric installations, light and power, as well as telegraph and telephone, against lightning; the other for a description of the production and the character of stray currents and their action in connection with electric railroads, and on methods of observing their strength and indicating their course. The prizes are offered only to the members of that society; the papers must be handed in by Feb. 1, 1898; the prizes will be at least $125.

Biographical. MARCILLAC. *L'Eclairage Elec.*, Feb. 20.—A long biographical notice of the late Luigi Palmieri.

Safe-breaking by Electricity. RODMAN. *Elec. Eng.*, Feb. 24.—A short article continuing the discussion of this subject (see *Digest*, Feb. 6).—He claims that the burning of a hole through a safe by means of the arc is an extremely simple thing which people who have little or no knowledge of electricity can do with perfect ease; it is a perfectly practical and feasible operation. An editorial in the same issue gives the opinions of Prof. E. Thomson on this subject; he grants that it is quite possible to thus burn a hole through a safe, but the conditions are such that it would be a very difficult thing for a burglar to do; he thinks that 200 to 300 amperes would be required.

Biographical History of Electricity.—Amer. Elec., February.—The current installment of this serial is on the three Becquerels.

Paris Exhibition of 1900.—West. Elec., Mar. 6.—A list of the groups and classes pertaining to electrical exhibits.

Easy Inspection of Large Generators.

The following communication has been received from the Card Electric Company, Mansfield, Ohio:

"Attention has been called to an article on 'Easy Inspection of Large Generators,' recently described and illustrated in THE ELECTRICAL WORLD of Feb. 27 last, as being one of the most convenient methods ever devised for the purpose, and claimed to be the invention of Sidney H. Short, of Cleveland, O.

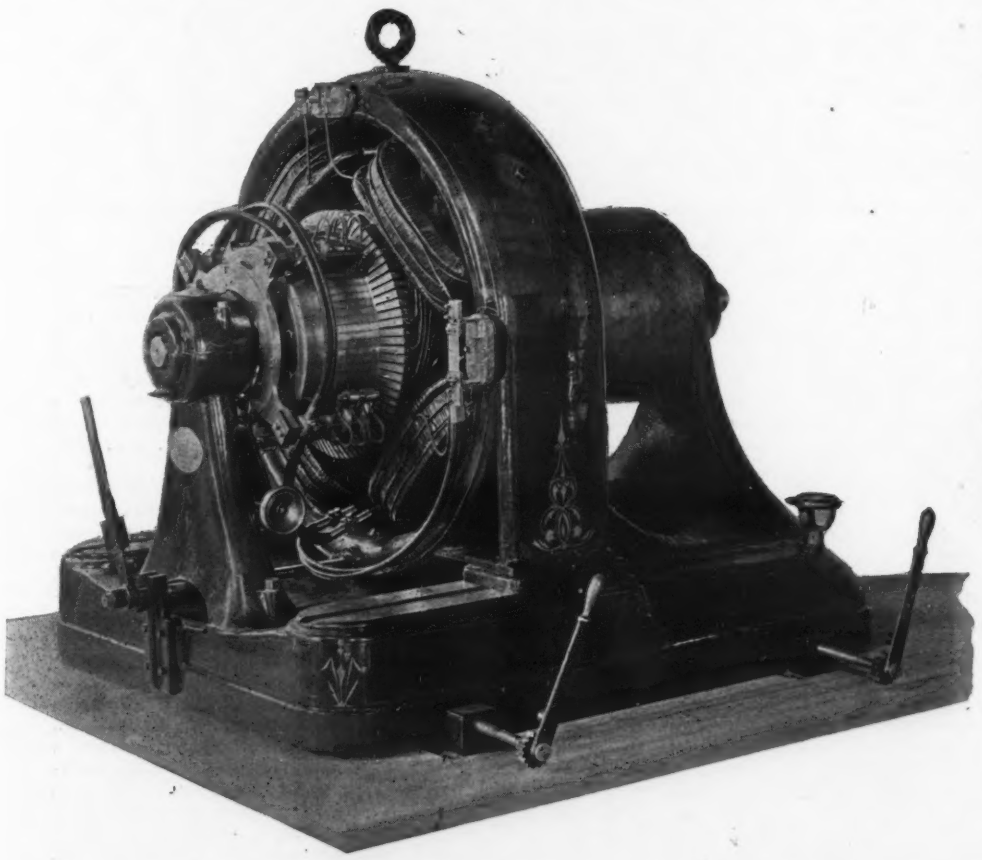
"It is an apparent fact that one-half the world does not know what the other half is doing, and after reading the article referred to we feel prompted to describe a method of facilitating an inspection of the kind mentioned, which is not by any means a new one, but one which has been in use for the past three years, and which was devised by our Mr. George F. Card.

"The accompanying illustration represents an improved generator manufactured by this company, and shows a novel and convenient method of moving the pole frame and field magnets away from the armature.

"The manner in which the pole frame and field magnets are mounted on the base and the convenience it affords for inspecting the armature or field coils can readily be seen. The brackets for supporting the pole frame have tongues cast on them on the under side, which are planed to fit in the grooved slides on each side of the base. On the front of the base is a bracket with a screw, which passes through a nut fastened to the bottom of the pole frame. With the ratchet lever the field core or frame and field magnets can be slid forward on the base, completely uncovering the armature. If it is desired to take the field core or frame entirely from the base, two pieces of timber made level and placed at the end of the base and a crowbar are all the tools necessary.

"The above method is applied to direct-driven as well as belt-driven generators. A number of the Card generators having this particular feature are at present being installed in various localities.

"The armature is supported on three self-oiling and self-aligning bearings; the two at the pulley end being cast together in a very rigid form."

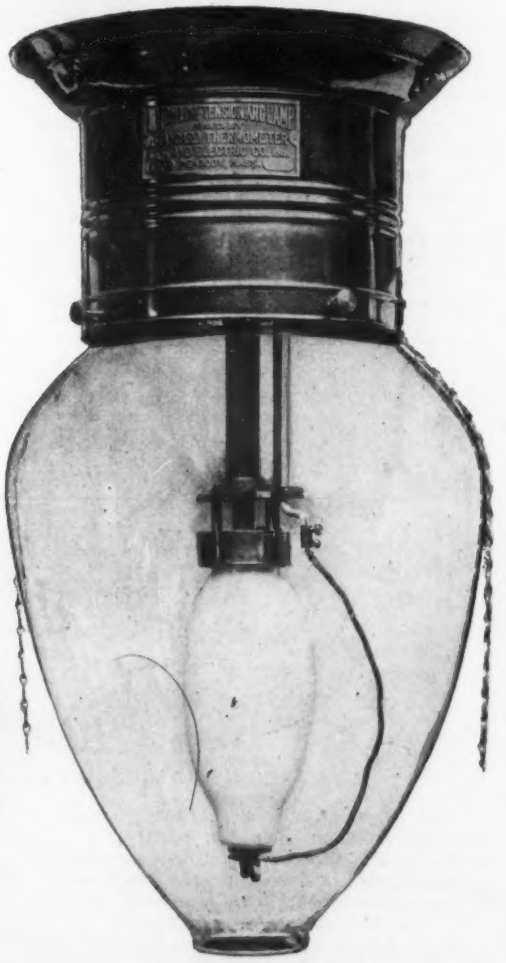


MACHINE WITH MOVABLE POLE FRAME AND FIELD MAGNETS.

A Novel Arc Lamp.

The desideratum in arc lamps for interior lighting is the combination of quiet burning and efficiency with beauty and small size. The success of the enclosed-arc lamps has been due to their quietness and efficiency, their steadiness of light and adaptability to incandescent circuits at the usual voltages. The competition between makers is leading rapidly to the selection of designs of extreme elegance for the exteriors of these lamps, while their increasing use in interior lighting has necessitated the shortening of the lamp to permit its suspension under low ceilings and in confined spaces.

The lamp illustrated herewith is the Upton Midget Lamp, made by the Standard Thermometer & Electric Company, Peabody, Mass. It combines elegance of design with very small size and the most extreme simplicity of construction. The mechanism of the lamp consists of a single solenoid which operates a lever connected with a clutch. At the end of the lever is a dry-air dash-pot. The upper carbon is held in a brass tube by a suitable holder provided with brushes bearing against the interior of the tube. The clutch embraces the carbon at its point of entrance into the enclosed chamber of opal glass surrounding the arc, and is insulated to prevent the formation of an arc between carbon and clutch. A single movement of the lower carbon-holder unlocks it from the enclosure globe and permits the trimming of the lamp. The resistance coil, used for lamps on constant potential circuits, is mounted in



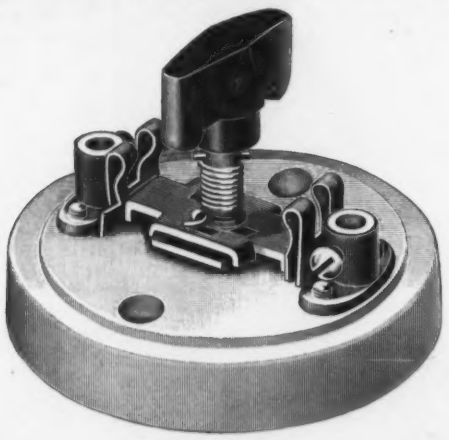
MIDGET ARC LAMP.

the upper case above the solenoid. The lamp, complete with the outer globe, is only 20 inches high, and without the globe, 18½ inches. A special form for show windows is made with concave or convex reflectors replacing the outer globe, to replace the ordinary group of incandescent lamps mounted in a mirror reflector.

The Hartford Switch.

The switch illustrated herewith is to be known to the trade as the "Hartford," being christened after the city of its birth. The maker, Mr. J. S. Gibbs, believes that the "Hartford" is his best effort thus far. Every feature of this new pattern, both mechanical and electrical, has been carefully designed to do the work satisfactorily for the user, and to meet all of the rigid requirements of the rules of the Board of Underwriters. The spring contacts are made of phosphor-bronze. This is considered a decided advantage, as this metal is said to retain its temper permanently and gives full and perfect contact at every movement.

The switches turn from left to right and are actuated by a coiled piano wire spring. The locking and unlocking device is a new combination in switch movements, being accomplished by means of a rack and pinion, which insures a positive, but very easy, action without strain or danger of cracking the porcelain base. All parts are substantially made, and are interchangeable, so that if by accident anything should become broken it can be readily replaced.



Hartford Switch.

The Hartford switch is made in all of the usual styles and sizes demanded by the trade, and can be bought of all electrical supply dealers. The Conover-Goe Company, Chicago, is the general sales agent for the factory.

25-kw Direct Connected Set.

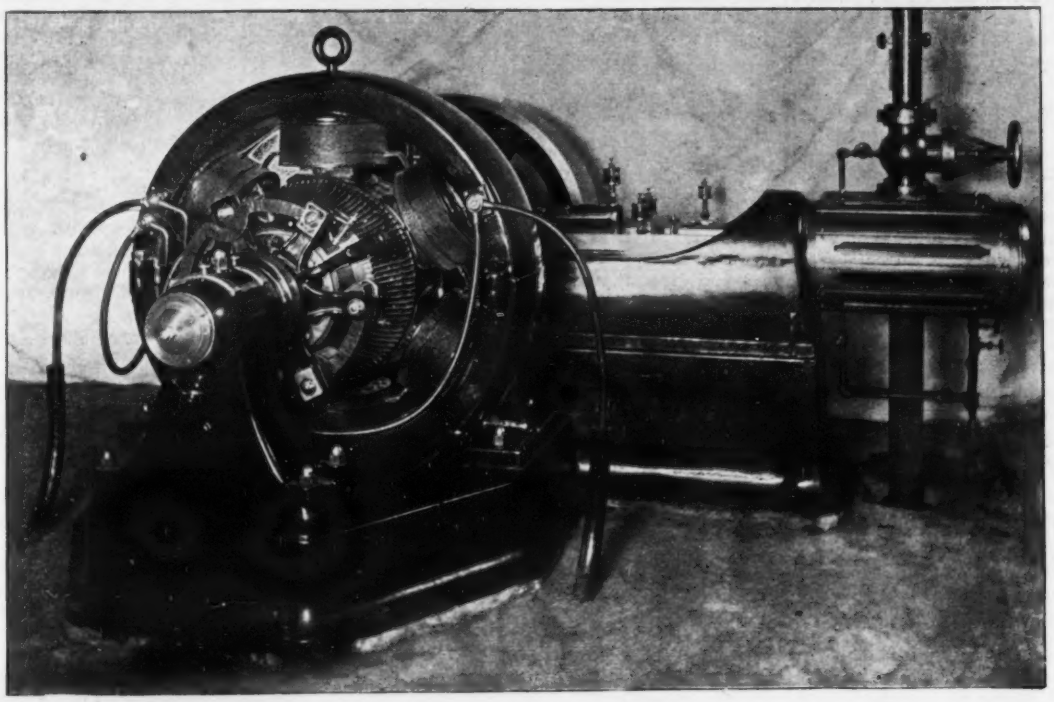
In the accompanying illustration is shown a direct connected dynamo built by the Onondaga Dynamo Company, Syracuse, N. Y., and recently installed in the Y. M. C. A. building in that city. It is of the six-pole ring type. The magnet yoke is made of special gray iron, and so designed as to make the machine pleasing to the eye and at the same time give the very shortest possible magnetic circuit. The magnet cores, which are made of soft charcoal iron, are cast solid in the magnet yoke, thus doing away with all unnecessary bolted joints, which are a source of great loss in any magnetic circuit; this construction requires, therefore, a minimum amount of magnetizing power.

The pole shoes or rings are bored out and slipped over the magnet cores, thus allowing the wrought cores to extend through to the air gap. They are so shaped as to do away with all humming noise.

All of the machines made by this Company are provided with self-aligning, self-oiling ball and socket bearings, and are constructed so as to avoid all leakage of oil. They are also provided with glass oil gauges.

The armature core is constructed of discs of special charcoal iron held together by cast iron plates bolted together under hydraulic pressure.

The core is thoroughly ventilated by longitudinal openings, also by openings perpendicular to the axis of the core. By this arrangement the entire machine is maintained at a low, even temperature.



Direct Connected Set.

The Range and Accuracy of Wheatstone Bridge Measurements.

BY IRVING B. SMITH.

Resistance measurements by the Wheatstone's bridge method are, within certain limits, both accurate and convenient. What these limits are and what the accuracy attained, are questions so often asked that a discussion of the subject will doubtless be of some interest. It is not sufficient that an instrument be "accurate" in its indications. That is too indefinite a term. All methods are subject to error, and a method which is accurate for one purpose, might be seriously inaccurate for others. It is, therefore, important that the degree of precision in any measurement be known.

A solution of the problem applicable to general conditions would be too lengthy and intricate to present any value for most measurements. A more practical turn will, therefore, be given the subject by considering it with reference to but one type of instrument, the portable testing set. To be widely useful, a portable set should be compact and complete. It should contain within itself all accessories and connections for rapid measurements. In designing such a set, care should be taken that the sensibility and resistance of the galvanometer, the E. M. F. and the resistance of the battery, and the accuracy of adjustment and values of the coils, bear such a relation that no one of these elements shall so influence the others as to unnecessarily diminish the effect toward securing a high degree of accuracy in the values obtained.

For the measurement of any particular resistance, there is always a certain value for each of these elements necessary to secure the highest accuracy. The problem in designing is to adopt such values as will give the best all round results in measuring the resistances usually found in practice. Certain of the constants have their values limited or set by practical considerations. For example, the size of the set, that it may be portable, limits the size wire and number of coils permissible in the bridge arms and rheostat. The size of the wire limits the accuracy to which the coils can be practically adjusted. The choice of battery suited for this work is confined to but few forms, and the number of cells is necessarily small. The cells must be small, the resistance low, liquids should be avoided, and ready means provided for renewing the battery when exhausted.

The galvanometer demands careful attention. It must be small, and

at the same time have a high sensibility. It should not require leveling, nor should it be influenced by external magnetic fields or currents.

The following specifications will prove desirable:

Rheostat to have coils ranging from one to five thousand ohms, making a total of over ten thousand ohms.

Bridge arms to have coils of 1, 10, 100 and 1000 ohms each; or 1, 10 and 100 ohms in one arm, and 10, 100 and 1000 ohms in the other, with a plug commutator to reverse the position of the arms. This dispenses with two coils. As will appear later one of the 10-ohm coils in the last arrangement may have substituted for it a very low or a very high coil, or a shunt for the galvanometer, without diminishing the accuracy or range of the set.

The size wire in each coil of more than five ohms resistance, to be

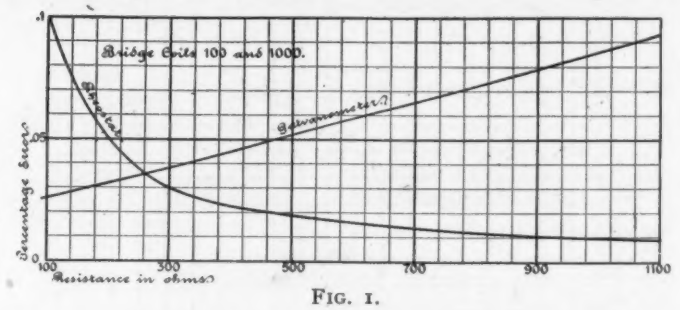


FIG. 1.

such that an accuracy of one-tenth of 1 per cent. can be secured, without too much readjustment. This permits the coils of values specified above to be contained in a sufficiently small space. In most work it is enough for the coils to be adjusted to an accuracy of one-fifth of 1 per cent. This is evident when one considers the effect of temperature changes. As a rule, measurements are made hastily, without corrections for temperature and the temperature coefficient of the resistance wire ordinarily used, such as platinoid, annuls any greater accuracy than one-fifth of 1 per cent. in the adjustment of the coils, unless temperature corrections are made. And even should the temperature changes in the set be small enough to be considered negligible, the probabilities are the same, or a larger limit would still be set by the temperature variations in the wire being measured.

The Galvanometer.—The annoyance of broken suspensions, the delay in leveling, and the uncertainty of instruments influenced by external magnetic fields, combine to exclude all but the D'Arsonval galvanometer, mounted in jewels. This, then, is the galvanometer chosen, and it should be designed to secure a fairly high sensibility with low resistance. As will appear later, a sensibility of 0.5 megohm can be reached while keeping the resistance below 300 ohms.

There is such a diversity of meaning in the word "sensibility" that an explanation of the terms, as used in this article, will be, perhaps, a necessity. The sensibility of a galvanometer is expressed by that resistance which it would be necessary for the galvanometer circuit to have, when subjected to an E. M. F. of 1 volt, in order that the current flowing would be just sufficient to deflect the galvanometer pointer one degree on its own scale, or will displace a spot of light one millimetre on a scale distant one metre if a mirror and light be used.

From this definition it follows that, if a galvanometer be furnished with both a pointer and mirror, and the sensibility be determined, first by reading from the pointer and then with a lamp or telescope and scale, the two expressions so found will differ materially, the latter indicating a much higher sensibility than the former value. Therefore, a statement of the method adopted in finding it will be necessary in giving the sensibility.

This may seem a serious discrepancy, one that will lead to confusion, but the difference is not so serious as it is great. There is a constant ratio existing between the expressions found by the two

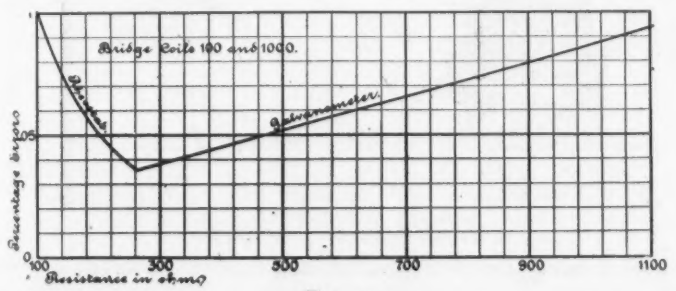


FIG. 2.

methods. The angular movement of a mirror, when it produces a displacement of a spot of light 1 mm on a scale distant one meter, is about 1′ 42″. By the first method the angular movement is 60′. The ratio is about 35:1. So a galvanometer, having a sensibility of 0.5 megohm, measured by the pointer, will have, when found by the other method, a sensibility of 17.5 megohms. But if this galvanometer were furnished with a pointer only, to call its sensibility 17.5 megohms would be misleading, and actually incorrect, for, if 17.5 megohms resistance were placed in circuit and subjected to a difference of potential of 1 volt, the movement would be so slight, without a telescope and scale, that it could not be discerned, not to say measured. The actual displacement of the end of a four-inch pointer would be 0.004 inch, assuming no reduction owing to friction. Practically it would be considerably diminished.

It follows from this that the sensibility of a galvanometer, although a function of the instrument, is also a function of the method employed in finding it. And this is properly so, for the expression for sensibility should be a measure of the practical utility of the instrument for the work it is intended, and if the construction of the galvanometer restricts our choice of methods for reading its indications to a more or less inaccurate one, then the useful sensibility of the galvanometer is correspondingly reduced. The unit chosen as a measure of the galvanometer sensibility, namely, one degree, is a convenient one. The length of pointer on a portable galvanometer is usually not far from four inches. On a circle of such radius one degree subtends an arc of nearly one-tenth of an inch. This is a convenient space for graduating and not too small to divide into tenths by inspection.

Battery.—The ready means of temporarily increasing the battery power at any time, by the addition of outside cells, is a sufficient reason for keeping the number in the set small, say from five to ten. The most suitable cell is the silver chloride.

The sensibility of the galvanometer was assumed to be ½ megohm. A deflection of one-quarter scale division is readily apparent; therefore a current of .0000005 amperes through the galvanometer can be detected.

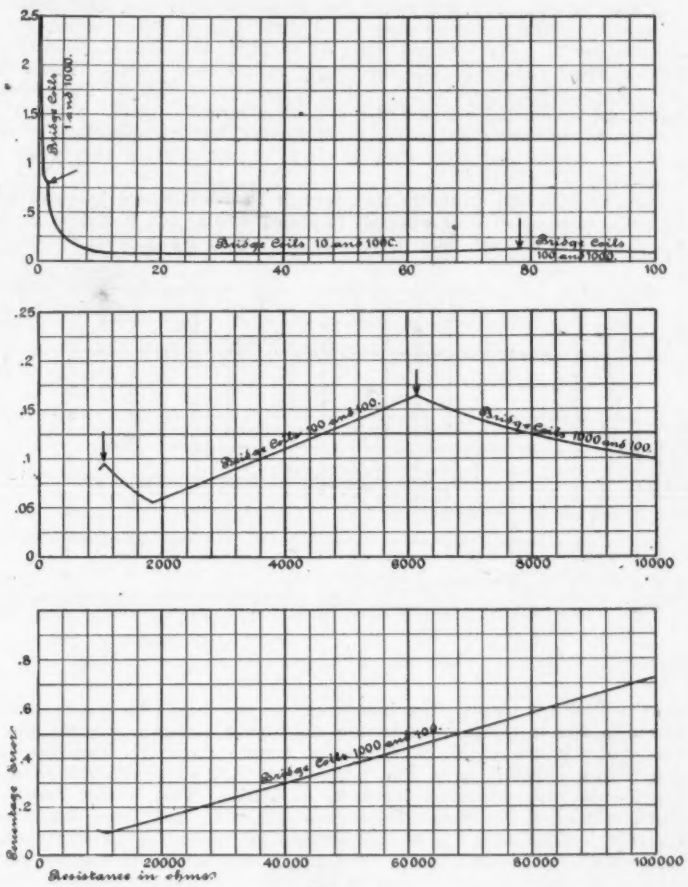

Bridge Coils 1 and 1000.
Bridge Coils 10 and 100.
Bridge Coils 100 and 1000.
Bridge Coils 100 and 100.
Bridge Coils 1000 and 100.
Bridge Coils 1000 and 100.
Percentage Error.
Resistance in ohms.

FIG. 3.

The general equation for the error in the result of any measurement is:

$$\lambda = C_6\, r\, x \left(\frac{d + g + x + \frac{g\,x}{a}}{E} \right) \left(\frac{1}{d} + \frac{r + x + a}{r\,x} \right)$$

The values so far assumed are:

$C_6 = 0.000{,}000{,}5$; $r = 100$; $g = 300$; $E = 10$.

Substituting these values reduces the equation to:

$$\lambda = x \left(d + \frac{300 + \frac{300\,x}{a}}{200{,}000} \right) \left(\frac{1}{d} + \frac{100 + a}{100\,x} \right)$$

Assuming a value for d in terms of x, and a value for a, we will have an equation for λ in terms of x. We will, however, multiply this value of λ by $100/x$ and obtain $\lambda^1 = \frac{100\,\lambda}{x}$. λ is the percentage accuracy of any adjustment. Or, more precisely it might be called the precision of adjustment expressed as a percentage. It is not truly a measure of the accuracy attainable, since the effect of errors in adjustment of the set does not enter, nor does the effect of the temperature changes.

Plotting this equation will furnish an easy method of inspecting the data. Owing to the rheostat being divisible only to units the curve gives percentage errors smaller than can be sometimes attained, since it assumes indefinite subdivision of the rheostat. Therefore, in connection with this curve, it is necessary to plot another, showing the percentage error introduced when the total resistance unplugged in

the rheostat is one unit too high or too low. This last curve gives the precision of adjustment on the assumption that the galvanometer sensibility is high enough not to influence the result. Fig. 1 is such a pair of curves for resistances from 10 ohms to 100 ohms, and with bridge arms of the following values:

$$a = 10\,;\ b = 1000\,;\ d = 100\,x.$$

It will be noticed that the curves cross one another, indicating that for some values the percentage accuracy is limited by the sensibility of the galvanometer, while for other values it is limited by the range of adjustment of the set.

Fig. 2 is a broken curve, formed by discarding those parts of the curves in Fig. 1 which indicate, each a higher degree of accuracy than that indicated by the corresponding part of the other curve. This curve, therefore, gives the accuracy to which a resistance can be adjusted with the bridge arms assumed.

Proceeding in like manner with the other values possible for the bridge arms, there results a series of curves. Plotting these on one sheet and rejecting all parts of these curves which do not assist in forming the lower contour line, there is obtained a final broken curve, showing at once the best values to be given the bridge arms for any measurement and showing also the accuracy attainable.

It may be advanced this result can be obtained by the trial method, using the various bridge values until that ratio is found which gives the best result. This method could be adopted, and, indeed, usually is, but one must either tabulate the proper values once for all, by making the different measurements, or else in any measurement try several ratios and select that result which is most accurately found. As usually tabulated, the values are in the main correct, but an inspection of the curve in comparison with such a table, shows wherein the latter is sometimes at fault.

The curve in Fig. 3 shows that certain resistances can be more accurately determined than others. It indicates also the useful range of a set, such as the one here described. It is practically from one-tenth

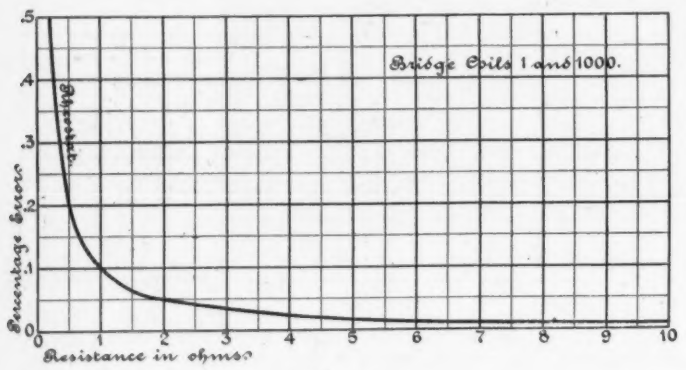


Fig. 4.

ohm to 5,000,000 ohms. The inaccuracy of the high and low measurements is due to the battery having too high a resistance in the latter case and too low an E. M. F. in the former case. To illustrate the extent to which this is so, Fig. 4 is plotted with all conditions, excepting the battery resistance, the same as before. This is now taken 10 ohms, instead of 100 ohms. The values of a and d are 1 and 1000 x, respectively. The accuracy is considerably increased. A one-tenth ohm coil, before measurable to two per cent., is now known to one per cent. In this manner the useful range of the set can be extended to 0.01 of an ohm. With equal effect the value of the higher measurements can be increased by using a battery of higher E. M. F. A battery of 100 volts E. M. F. gives the curve shown in Fig. 5. A resistance of 5,000,000 ohms before measurable to 50 per cent., is now measured to an accuracy of 5 per cent.

Besides the use of auxiliary batteries, still other methods may be employed to extend the scope of the set. They usually require some change, however.

For measuring insulation resistances by direct deflection method, have the divisions on the galvanometer scale proportional to the current producing the deflection. Then furnish means for shunting the galvanometer with a suitable coil to enable the sensibility to be found. If possible the shunt should be of low resistance, so that the sensibility can be found with five or ten cells of battery. This reduces the error due to differences in the voltages, and is a safe method if a series resistance be also inserted to annul the effect of the battery resistance. In this way, the set may be used to measure insulation resistance as high as 50 megohms with a hundred-volt battery. Other uses will suggest themselves when one becomes accustomed to relying on a portable set. For instance, comparing potentials by the fall of potential method, measuring battery resistance by a modified Mance's method, etc.

It is the custom of most instrument makers to permit their sets to go out with no certificate as to the accuracy of adjustment or value of the constants. This is wrong, not only because it prevents the user from gaining an idea as to the accuracy of his measurements, but also because it permits the maker to slight his work, knowing there is no guarantee placed upon it.

A set designed to meet the requirements enumerated in this article is now manufactured. It is small, measuring but nine inches in length, and the weight is reduced to a minimum.

The battery is in a separate cell box, readily removed at any time. The battery resistance (of 6 cells) is less than 20 ohms, its E. M. F. about 5 volts. The galvanometer scale is well lighted, enabling small deflections to be noted. The galvanometer resistance is below 300 ohms and its sensibility one-half megohm.

It is thus evident that in the choice of constants in the first of this article we have taken values which can be secured in practice. In fact, we have erred on the safe side, since most of them have in the set a better value. The battery resistance is lower; the galvanometer resistance is lower; and one can notice a smaller deflection than one-quarter scale division. By causing the galvanometer key to keep step with the swing of the pointer, it is easy to multiply a movement that would

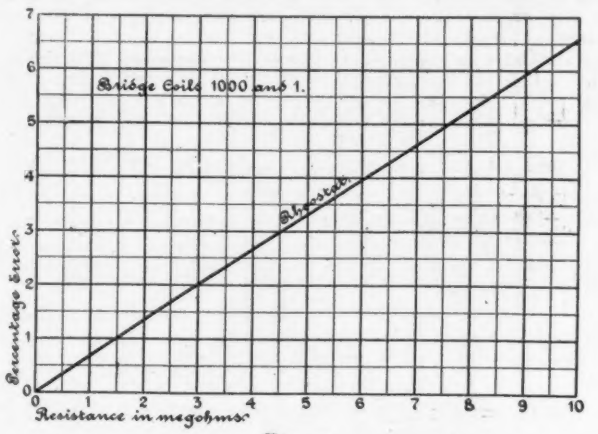


Fig. 5.

otherwise be unnoticeable. The bridge coils in the set are adjusted to an accuracy of one-tenth of 1 per cent., and the rheostat coils to an accuracy of one-fifth of 1 per cent. When desired, they can be adjusted to one-twentieth and one-tenth of 1 per cent., respectively.

When so ordered, the set is modified to adapt it to various different uses. Sometimes a standard cell and higher power battery are placed in its case, or a high resistance and extra battery power.

A careful description accompanies each set, enabling one not accustomed to such work to make accurate measurements.

An Electro Pyrometer.

BY L. K. BÖHM.

A novel utilization of the electric current is its application in pyrometry. The exact measuring of high temperatures has remained up to a recent date a problem, and the instruments employed for this purpose were more or less defective. The principles on which pyrometers are based are manifold. Musschenbroeck employed a metal rod whose expansion indicated the temperature on a scale by means of a hand connected to the metal rod by a lever device. Wedgwood constructed a pyrometer of two converging metal rods and air-dry clay balls, which, when heated, shrink and go further in between the converging rods. The air pyrometer was evidently the best known, but its application is limited. Prinsep determined the temperature by the fusion of little

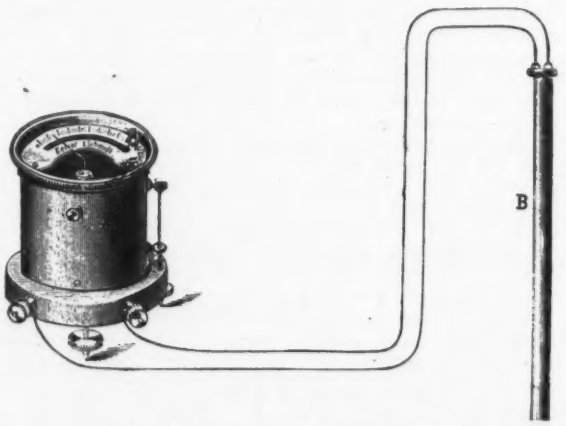


Fig. 1.—Electro Pyrometer.

pieces of metal alloys. All these pyrometers, with the exception of the air pyrometer, do not give accurate results, but they permit of judging the temperature, or rather of guessing it, and the exact measurement of high temperatures has remained a difficult task until the problem was solved by the aid of electricity.

Only two pyrometric methods can be considered as reliable for measuring high temperatures. The first was introduced by Sir William Siemens, and is based on the fact that an electrical resistance is varying with the temperature. but this pyrometer cannot be used for very high temperatures, as there is no material which will insulate sufficiently well at very high temperatures. A further deficiency in this instrument is that the resistance coil is of relatively large volume, and, therefore, it is only possible to measure the middle temperatures of large spaces, while it is often desired to measure the high temperature of a small space.

The second method is based on the fact that a weak thermo-electric

current is generated when a thermo-element is exposed to heat. The thermo-element is free from all the deficiencies of which the resistance pyrometer is possessed, and the requirements for insulation are within practical limits.

A suitable thermo-element for measuring high temperatures has been devised by Le Chatelier.[1] It consists of platinum and of an alloy of platinum with rhodium. In order to obtain reliable data of this thermo-element, Drs. Holborn and Wien have made exhaustive researches in the Physikalische Technische Reichsanstalt, in Charlottenburg.[2] The gratifying results obtained by Drs. Holborn and Wien induced them to procure a pyrometer for technical purposes. They requested the firm of W. C. Heraeus, the celebrated platinum refiner and platinum apparatus manufacturer of Hanau, Germany, New York office, 41 Cortlandt Street, to manufacture these pyrometers, and this firm has manufactured them, together with the firm of Keiser & Schmidt, of Berlin, Germany, who constructed a special galvanometer for this instrument.

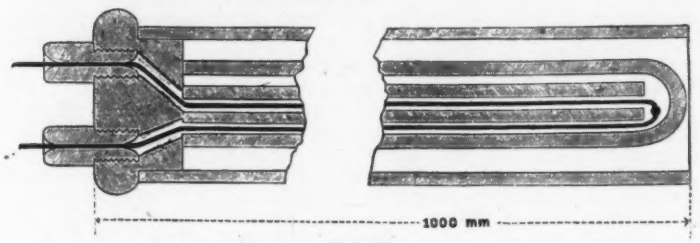


FIG. 2.

The pyrometer manufactured is shown complete in Fig. 1, a section of the thermo-element is shown in natural size in Fig. 2, and Fig. 3 represents the scale of the galvanometer. The thermo-element consists of one wire of pure platinum and one wire of an alloy of platinum with 10 per cent. of rhodium. The two wires are fused together, with the ends forming a small ball, as is shown in Fig. 2. If this small ball is heated a weak electric current is generated which is proportional to the temperature. The two ends of the thermo-element which are not soldered together are connected with the galvanometer, which indicates the strength of the current. Each element is provided with a table of temperatures obtained by comparison with a standard air pyrometer, and by comparing the table and the strength of the current the temperature is read. It is, however, more convenient to read the temperature directly from the galvanometer, whose scale indicates the microvolts and the degrees of temperature, as is shown in Fig. 3.

It is important that the resistance of the circuit is not much more than one ohm. The galvanometer may be at any desired distance from the furnace whose temperature is to be measured; it is connected to the thermo-element by common copper wire. Thus it is plainly seen that the temperature of a furnace can be controlled at the office, without going near the furnace.

The small ball forming the joint of the two pyrometer wires is about 1 mm. thick, and in order to measure a temperature it is only necessary to bring the small ball directly in the furnace or in a metal bath, or any

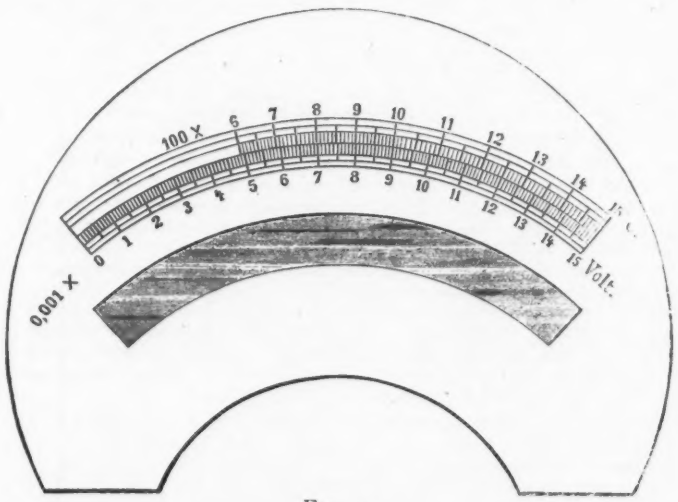


FIG. 3.

other place the temperature of which is to be ascertained, when the galvanometer indicates at once the current generated and how high the temperature is, and any slight variation of the temperature is at once observed on the galvanometer.

It is understood that the wires of the thermo-element must not be brought in contact with substances which form chemical compounds with platinum. The same care must be taken with the element as is taken with any platinum apparatus. For these reasons the element is generally mounted in a porcelain tube, which is closed on one side for the purpose of protecting the wires from the flames; a small porcelain tube open on both sides is used inside, which insulates the wires from each other. These porcelain tubes are made by the Royal Porcelain Factory, in Berlin, of a special quality of porcelain, which hardly fuses. The tubes resist temperatures of 1600° C.

The galvanometer is based on the principle of Deprez-d'Arsonval. A solenoid wound in the form of an oblong is excited by a current passing through a filamentary wire of hard non-oxidizable metal and a fine spiral spring of the same material. The latter opposes the rotary movement of the current. Three strong magnets, provided with pole shoes, form a magnetic field, in whose centre a stationary iron cylinder concentrates the magnetic lines of force. The little drum around which the wire is wound swings accordingly and completely aperiodic, the deflections are proportional, and as the hand returns without swinging, the readings are quickly and correctly made.

The hand is above the scales, of which one indicates the E. M. F. in microvolts for the purpose of controlling the instrument, while the second scale permits of reading the degrees of temperature directly.

If the galvanometer is at a considerable distance from the furnace, say about 300 feet, then the copper wire connecting the galvanometer and the thermo-element should be insulated and about 2 mm. in diameter. For longer distances the wire should be thicker in proportion.

The thermo-element is generally composed of platinum, with the platinum alloy containing 10 per cent. of rhodium, but tests have been made with 9, 11, 20, 30 and 40 per cent. of rhodium. The comparison of elements with various percentages of rhodium showed that the thermo-electric current at high temperatures increases considerably with the increase of the percentage of rhodium, while for lower temperatures the differences are much smaller. The increase of the thermo-electric force is nearly constant with a percentage of rhodium between 10 per cent. and 40 per cent. From this results that an exact and fixed percentage of rhodium is not necessary. It is more important that the platinum and rhodium are chemically as pure as possible.

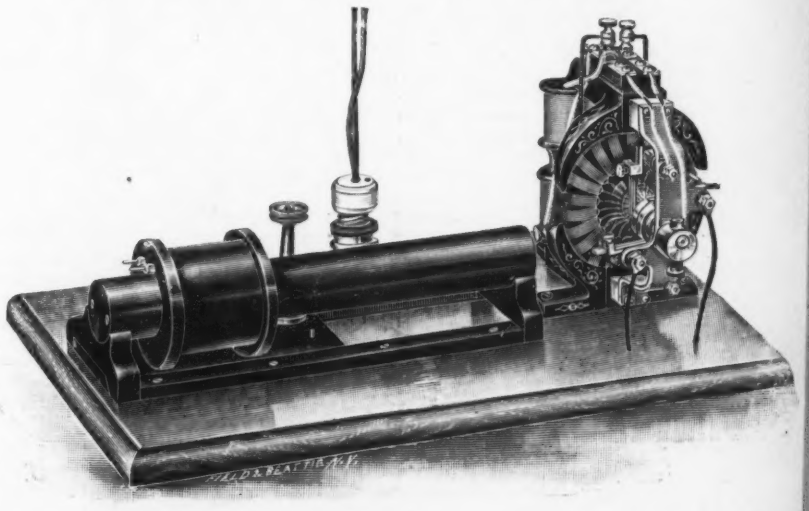
The electro-pyrometer is constructed for various demands and for all temperatures up to 1600° C., or nearly 3000° F. It finds also application in electrical works, where it has been used successfully for regulating the temperatures of the carbonizing furnaces in incandescent lamp factories, and adjusted for lower temperatures of about 600° C. in accumulator factories.

[1] Le Chatelier, *Jour. de Phys.* (2), page 26, 1887.
[2] *Wiedemann's Annalen Band*, 47, 1892.

Direct-Current Cautery Transformer.

Physicians who have available in their offices direct current of from 110 to 120 volts pressure will be interested in the apparatus illustrated herewith. In electro-cautery work these currents can be used in conjunction with this apparatus with a degree of safety which is claimed to be absolute. The apparatus, which is manufactured by the Edison Manufacturing Company, No. 110 East Twenty-third Street, New York City, is as well suitable for hospital work, since many of the most prominent institutions of this character are lighted by Edison current. It consists of a 120-volt Edison motor, the armature shaft of which is provided with two collecting rings, which are connected to the armature at points diametrically opposed.

The current taken from these collecting rings, which is now of an



CAUTERY TRANSFORMER.

alternating character, is led into the primary circuit of the transformer, shown on the left of the cut. The primary circuit is composed of a number of turns of fine insulated copper wire wound round a core of annealed iron wires, the whole being inclosed in a thin cylindrical shell of hard rubber, which is supported by a hard rubber standard at each end. The secondary coil, composed of a few turns of thick wire, is wound on a hollow hard rubber spool, operated by a rack and pinion movement and sliding over the primary coil. The terminals of the secondary coil are brought out to two pin attachments mounted on one head of the coil, and the cautery cords are connected thereto by split socket connections. On moving the secondary coil to the right, the current is increased, and vice versa.

The apparatus is mounted on a highly polished oak base, and is provided with an attachment plug and ten feet of flexible cord for connecting the instrument to the mains.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, March 9, 1897.

ELECTRICAL STOCKS.—At this writing this class of securities shows a downward tendency as compared with the quotations in our last report. With the single exception of Westinghouse pfd. all changes are on the minus side, the losses, however, being merely fractional.

TELEGRAPH AND TELEPHONE.—This list was not affected by any general influence, some advances and some losses being noted at the time of making up this report. Bell Telephone lost half a point and Western Union a fraction; American Telegraph & Cable advanced 2 per cent., but Commercial Cable stands at the head of advances, an improvement of 4 points being recorded.

ELECTRIC TRACTIONS.—No marked changes are recorded in this class of securities, the general market being quiet, but tendency being towards the downward side. The few changes, however, were only fractional. The bond list is unchanged, with the exception of Brooklyn Rapid Transit 5s, which advanced ⅞.

THE NEW YORK & NEW JERSEY TELEPHONE COMPANY.—The annual report of this Company shows gross receipts during 1896 of $1,554,585; net receipts, $370,461. Of this, $253,363 was set aside for dividend purposes, leaving a surplus of $117,098. The following named gentlemen were elected directors: C. F. Cutler, A. Cameron, J. P. Davis, C. A. Nichols, H. Kinnard, W. D. Sargent, D. B. Powell, G. H. Prentiss, J. C. Clark, F. Campbell, E. J. Hall and H. S. Snow.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	110	..
Edison Electric Ill., New York	100	105½	106
" " " Brooklyn	100	..	97
" " " Boston	100	..	..
" " " Philadelphia	100	..	..
Edison Ore Milling	100	7½	10
Electric Storage Co., Philadelphia	100	26½	28
Electric Storage, pref	100	28⅞	29
General Electric	100	34⅞	35⅛
General Electric, pref	100	75	77
Westinghouse Consolidated, com	50	24	25
" " pref	50	51	52

BONDS.

Edison Electric Ill., New York, con. 5s	105	108	..
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	96	..

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	223½	225
American District Telegraph	100	29	39
American Telegraph & Cable	100	87	89
Central & South American Telegraph	100	124	127
Commercial Cables	100	160	172
Erie Telephone	100	66½	68
New England Telephone	100	102¾	..
Postal Telegraph-Cable	100	..	..
Western Union Telegraph	100	82⅝	82⅞

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	18	18¼
Brooklyn Rapid Transit	..	20¼	21
Brooklyn Traction	100	..	14
" " pref	100	46	48
Buffalo St. Ry	100	71	75
Cleveland Electric Ry	100	..	..
Columbus St. Ry	100	40	43
Hestonville	100	51	51½
" pref	..	..	62½
New Orleans Traction	100	..	10
" " pref	100	..	35
North Shore Traction	100	20	23
" " pref	100	77	80
Rochester St. Ry	..	18	22
Steinway Ry	..	45	50
Union Railway (Huckleberry)	..	98	103
Union Traction, rcts $10 pd	..	12¾	13
West End, Boston	100	74	74½
" " pref	100	91	91½
Worcester Traction	100	20	22
" " pref	100	94	97

BONDS.

Brooklyn Rapid Transit 5s, 1945	100	81⅛	..
Buffalo St. Ry. 1st con. 5s	100	*106	108
Cleveland Elec. Ry. 1st mtge. 5s	100	103	105
*Columbus St. Ry. 1st 5s	100	94	96
Rochester St. Ry. 1st 5s	100	..	100
Union Railway (Huckleberry) 1st mtge. 5s	..	*101	104
*Westchester Electric 1st mtge. 5s	100	100	103

*With accrued interest.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, March 9, 1897.

THE HENRY ELECTRICAL SOCIETY.—At the meeting of the Henry Electrical Society, which will be held on March 19 next, Mr. W. H. Freedman will lecture on "American Telegraphy," in which he will explain the duplex and quadruplex systems. On April 2 Mr. W. B. Potter will lecture on "Electric Railway Batteries."

WELL-KNOWN GENTLEMEN IN NEW YORK.—The following named gentlemen registered their names at the headquarters of the National Electric Light Association during the week ending Mar. 6: F. S. Marr, Philadelphia, Pa.; T. H. Brady, New Britain, Conn.; T. Bibber, Boston, Mass.; F. P. Kennedy, Fulton, N. Y.; A. J. Smith, Cleveland, Ohio; J. H. Reid, Pittsburg, Pa.; H. B. Cutter, Philadelphia, Pa.; E. L. Babcock, Cuyahoga Falls, Ohio.

MR. EDWARD R. KNOWLES, the well-known electrical engineer, has for some time past been giving special attention to the various applications of electric power. Mr. Knowles has a most ample experience of over fifteen years in nearly all branches of electrical application, having been prominently connected with several of the pioneer electrical concerns. The recent electric traction work on the New York and Brooklyn Bridge was entirely supervised by Mr. Knowles as consulting engineer. He is also similarly retained by the *New York Journal*, The Mergenthaler Linotype Company, The Arc Welding Company, the *San Francisco Examiner* and others. Mr. Knowles' New York office is in the American Tract Society Building, 140 Nassau Street.

MR. FRANK J. SPRAGUE, the prominent electrical engineer, and president of the Sprague Electric Elevator Company, recently met with a severe accident to his right leg which has incapacitated him for active business for some weeks to come. Mr. Sprague was inspecting the installation of some of his electric elevators at the new Waldorf Hotel, and accidentally stepped backward from a plank resting on some pipes, thereby severely straining his knee joint. To a man of Mr. Sprague's activity, confinement to his room is not particularly pleasant, and we certainly extend to him our sympathies with hopes for his speedy recovery. It may be noted that Mr. Sprague is at present busily engaged upon some matters connected with the application of electric power to the New York elevated railways.

FIRE AT THE SPRAGUE ELEVATOR WORKS.—A fire which might have resulted in very serious damage started at 2 o'clock Tuesday morning, March 9, at the Sprague Electric Elevator Works, Watsessing, N. J. Due to the immediate discovery of the fire and the active steps taken by both the fire corps of the company and the local fire department, the absolute destruction of the works was prevented. The damage, however, amounted to $25,000, which is fully covered by insurance. The principal damage by the fire was to the roof and floors, while the tools were more or less damaged by water. Immediate steps were taken after the fire to put the works into condition to get out the many large orders which the Sprague Company has in hand at the present time, including twenty-one electric elevators for the Astoria Hotel, five machines for the Queen Insurance building, three machines for the Telephone building, six machines for the Commercial Cable building and numerous others. The installation and completion of elevator machinery for these installations will not in any way be interfered with. The actual cause of the fire is somewhat in doubt, although various rumors are afloat regarding it being of incendiary origin. It may be noted in this connection that there is some difficulty at the present time between the machinists' labor union and the elevator constructors, and a strike at the works has been threatened by the labor union for some time.

NEW ENGLAND NOTE.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, MASS., March 9, 1897.

DISASTROUS SUBWAY EXPLOSION.—On March 4, a few minutes before noon, occurred an explosion of illuminating gas in the subway at the intersection of Tremont and Boylston Streets, Boston, which resulted in the death of nine persons and the injury of two score or more others. Buildings within hundreds of feet in every direction were damaged by the concussion, and several electric cars which were passing at the time were wrecked. Cars and carriages were tipped over and their occupants thrown out into the midst of the general wreckage, and the flames from the opening in the street seized upon the splintered wood of the cars which had been torn apart and soon a brisk fire was burning. Fire engines were called immediately, and in a short time the firemen succeeded in extinguishing the flames. Trolley wires which had been broken dangled dangerously in all directions, and before the work of rescuing the victims could be begun it was necessary to have the power shut off at the power-house. One of the cars was directly over the spot where the explosion took place and was raised bodily from the track by the force of the concussion, and, dropping back, it split in two and became a prey to the flames. The conductor of this car, B. R. Sargent, was so seriously hurt that he afterwards died from the effects of his injuries. Near this car was a horsecar, both horses of which were killed by the explosion. The driver of this car was also killed. Most of the victims were passengers on the cars which were destroyed. The property loss was estimated at $35,000.

PITTSBURG NOTES.

PITTSBURG, PA., March 8, 1897.

THE CENTRAL DISTRICT & PRINTING TELEGRAPH COMPANY has asked Bellevue Councils for rights of way on the Borough streets. A number of residents have asked for telephone service, and the company states that it will establish an exchange in Bellevue as soon as it can secure the necessary franchise.

THE HOME TELEPHONE COMPANY'S ordinance, described in THE ELECTRICAL WORLD of Feb. 27, was approved last week by the committtee on corporations and recommended to Councils for passage. In the committee some disposition was shown to reduce the maximum rates from $48 to $35 for business houses, and from $35 to $25 for residences. This proposition was defeated, however, and the ordinance was approved as submitted by the sub-committee.

THE DIRECTOR OF THE DEPARTMENT OF PUBLIC WORKS on March 6 opened bids for an electric light plant to be installed at the Brilliant pumping station. The specifications called for one 75-kw direct connected 125-volt generator, one 60 light arc machine, one vertical compound engine, and switchboard and other accessory apparatus. Only two bids were received, viz.: One from the Westinghouse Electric & Manufacturing Company, of $9,867, and that of Westinghouse, Church Kerr & Co., amounting to $9,622. The contract will doubtless be awarded to the latter company.

THE WESTINGHOUSE GLASS COMPANY, Allegheny, Pa., will begin early in the Spring an addition to its factory that will nearly double its capacity. In addition to bulbs for incandescent lamps, this company manufactures arc light globes of all kinds, battery jars, and opal and etched shades of various designs for incandescent lamps and gas fixtures. Its green glass shade has made a decided hit and is displacing Belgian and Austrian imported ware. The demand for its product has reached a point where it can no longer be met with its present facilities, which will therefore be increased.

THE SPECIAL COMMITTEE appointed to settle the differences between Allegheny Councils and the traction companies, made a report to Select Councils on March 5, which completes its work as far as the North Side Traction Company is concerned. This company operates all the lines owned or controlled by the Federal Street & Pleasant Valley Company. The ordinance recommended by the committee, and which is acceptable to the company, provides that the company forthwith shall pay the city $30,325 in settlement of all claims for street-paving, repairing, and taxes; must this year pave between its tracks and one foot on each side thereof on all streets already paved by the city, and in the future must do its share of paving on any street whenever the city decides to pave such street; whenever the company re-lays any of its tracks it must pave between them and one foot on either side of them, whether the street was previously paved or not; and, finally, the company is to pay the city each year 2 per cent. of its gross income during the preceding year. The committee has not yet reported any arrangement with the Pittsburg, Allegheny & Manchester Company. It is estimated that the revenue derived by the city from the 2 per cent. tax on the North Side Traction Company's receipts during the present year will amount to about $10,000.

ST. LOUIS NOTES.

ST. LOUIS, MO., March 8, 1897.

DIRECT TELEPHONE LINE.—The Bell Telephone Company, which has been trying to make direct connection with Red Bud, Ill., has at last succeeded, and the line is now open for business.

THE NEW CONDUIT.—The engineers of the Kinloch Telephone Company, Charles H. Ledlie and Herbert A. Wagner, and the Electric Light, Power & Conduit Company have submitted their conduit specifications. The former will use the McRoy vitrified conduit and the latter the McRoy vitrified conduit, the H. B. Camp vitrified conduit or the cement lined iron pipe of the National Conduit Manufacturing Company. Work was commenced on the Kinloch conduit on Monday morning, 100 men being put to work.

RECEIVER FOR HIS OWN ROAD.—The People's Railway Company went into the hands of a receiver late Saturday afternoon, and the president of the road, Charles Green, was appointed receiver, with a bond of $200,000. A petition was also filed asking that a receiver be appointed for the Fourth Street and Arsenal Company. The precipitating cause was the failure of both lines to pay the semi-annual interest on the bonds of both roads. Part of the floating debt of the Fourth Street & Arsenal Street line was incurred in purchasing supplies for an electric line, which the company had not the means to operate.

COLORADO NOTES.

DENVER, COL., March 6, 1897.

THE DENVER TELEPHONE COMPANY is still making an effort to secure subscribers for a telephone system to be introduced in opposition to that of the Colorado Telephone Company. The company has not as yet a bona fide franchise. It claims that it has what is equivalent to a franchise in a resolution passed by the city authorities some years ago. The Board of Public Works has refused to grant a permit allowing the company to begin work, as it questions the validity of the franchise. The City Attorney has given a negative opinion in reference to the controversy, holding that the rights of the company should be passed upon by a court of competent jurisdiction.

THE BRECKENRIDGE & ALMA ELECTRIC RAILWAY & POWER COMPANY has just been organized to construct an electric railway for the transportation of ore and to distribute power for mining plants. Projects similar to this have heretofore been planned in Colorado, but many of them were killed by the hard times. There seems to be no reason to believe that the proposed installation here described will meet the same fate, for the reason that there is abundant capital back of the enterprise; there is an urgent demand for the railway and it is believed that the investment will be profitable. It is confidently predicted by many electrical and mining engineers that within a few years similar installations utilizing the power of mountain streams will be completed in many mining districts of the State. The road which the company proposes to build will extend from Breckenridge south to the town of Alma, a distance of about twenty miles, passing through a district in which many mines are located. It will connect with the Denver & South Park Railway at the former place and with a branch of the same railway at Alma. It is thought that the railway will be ready for operation some time next Fall. Among those interested in the project are said to be the following: J. P. Pierce, vice-president of the American Radiator Company, Buffalo; Melville E. Stone, of the Associated Press, Chicago; Judge Hibbard, Paul Merker, and W. F. Fox, Chicago; J. W. Boone, Syracuse, N. Y.; Henry Clews, New York, and J. W. Swisher, of Breckenridge, Col.

THE LEADVILLE ELECTRIC POWER & IRRIGATION COMPANY proposes to at once begin the construction of a dam at Sugar Loaf reservoir site about four miles from Leadville. In 1888 surveys were made by the government to determine sites practicable for the storage of water. Among the localities designated was that at Sugar Lake and the site was taken from entry so no person could file upon it. Investigations recently made showed that if a dam were constructed the water power could be utilized electrically and that the water thus used could then be directed to the Arkansas river and thence distributed in the irrigating ditches. The Leadville Electric Power & Irrigating Company was organized to carry this project into effect. It was necessary to secure the government's consent that the site in question should be restored to the public domain so that it could be acquired by the company. This consent has just been secured by Col. R. E. Goodell and Senator John H. Poole, manager of the Denver Consolidated Electric Company, who have just returned from a journey to Washington. In making the improvement the company will expend from $250,000 to $300,000. About 900 acres at Sugar Lake are now covered by water; when the dam is constructed the reservoir will have an area of 1900 acres according to the estimates. The dam will be 40 feet in height, 120 feet thick at the base and 15 feet at the top; it will be 261 feet long at the base and 580 feet at the top. The power station will be built at a point 345 feet below the dam, and it is estimated that 2000-horse-power will be generated. This will be carried electrically to Leadville, five miles distant, and according to existing plans will be distributed in the mines of the district. Work on the installation will commence next Summer and the company expects to be able to supply customers with power in 1898.

PACIFIC COAST NOTES.

SAN FRANCISCO, CAL., Feb. 27, 1897.

THE PACIFIC AUXILIARY FIRE ALARM COMPANY, San Francisco, recently paid a dividend of 5 cents a share on its capital stock.

THE REGER-ATWATER COMPANY has re-equipped the San Francisco & San Mateo Railway, with "Type K" overhead material. It has also put in a large stock of mica to supply the demands of the coast.

THE PACIFIC TELEGRAPH & TELEPHONE COMPANY is extending its lines from Los Angeles to San Diego, Cal. It will be a 300-pound

copper loop. On its completion a conversation can be carried on for a distance of about 1100 miles over the company's circuits.

THE PACIFIC ELECTRIC MOTOR COMPANY, San Francisco, is making radical changes in its power circuits, which receive their current from the mains of the Edison Light & Power Company. Its extensive power system is being re-equipped with 220-volt Westinghouse motors, using constant-potential direct current.

THE CALIFORNIA ELECTRICAL WORKS, San Francisco, recently received the contract for the wiring and switchboard of the new 15-story Spreckels building. Iron-armored conduit will be used. Each floor will have an independent circuit. There will be about 3000 lights in the building, 1500 of them being arcs. The switchboard will contain novel features not heretofore used. Messrs. Hasson & Hunt are consulting engineers for the owner. The company has completed a 1000-ampere, 3-volt dynamo of improved pattern for plating purposes. The Interior Conduit & Insulation Company, New York, has transferred its local agency to the California Electrical Works.

Canadian Notes.

Ottawa, Ont., March 6, 1897.

APPLICATION FOR A CHARTER.—Application is being made by McGibbon, Hogle & Mitchell, Montreal, to the Dominion Parliament for a charter to incorporate a company to be known as "The Continental Heat & Light Company," to carry on the business of developing and generating heat, light and power by any means, and of supplying the same to municipalities, corporations and individuals in Canada and elsewhere.

THE HAMILTON RAILWAY ABSORBED.—B. B. Osler, of Toronto, was in Hamilton this week and had a conference with the directors of the Hamilton Radial Electric Railway Company. As a result, it is stated, a deal is practically closed by which this railway passes into the hands of the Toronto syndicate which is trying to control all electric railways in and about Hamilton. It is intended to extend the radial road to meet the electric road from Toronto to Oakville, completing an electric railway from Hamilton to Toronto.

NEW RAILWAY.—As trustee for the company, Mr. T. C. Brigham, of Ottawa, is applying to the Dominion Parliament for a charter to construct a line of electric or steam railway to be known as the Hull, St. Louis Dam & Victoria Springs Railway Company. The capital stock is $1,000,000. Their first line of railway will be built from Cumming's Bridge to the Victoria Springs, a distance of six miles. Following this there will be a belt line around the city to St. Louis Dam and other suburbs. The construction of the road will be begun as soon as the charter is granted and the company obtain the right of way.

INGERSOLL RADIAL.—Under the bill introduced in the Ontario Legislature this week by Dr. McKay incorporating the Ingersoll Radial Electric Railway Company, power is sought to construct and operate an electric railway from Ingersoll as follows: To St. Mary's through or near the villages of Thamesford, Kintore, passing through the townships of North Oxford and East Nissouri; a line to the town of Tilsonburg, through or near the villages of Salford and Mount Elgin, passing through the townships of West Oxford and Dereham; a line to the village of Brownsville, through or near the villages of Verschoyl and Colloden, passing through the townships of West Oxford and Dereham. The capital stock is placed at $500,000, divided into 20,000 shares of $25 each. Bonding powers to the extent of $10,000 a mile are asked. Operations are to be commenced within two years and the road is to be completed within five years.

English Notes.

(From Our Own Correspondent.)

London, Feb. 24, 1897.

PRIVATE AND MUNICIPAL ELECTRIC LIGHTING.—The relative advantages, so far as consumers are concerned, of private and municipal electric lighting are being strikingly exemplified down on the south coast, where the towns of Brighton and Hove, although practically one, happen to be under different municipal management. At Brighton, as no doubt some of your readers are aware, there is a municipal central station, which, under the auspices of Mr. Arthur Wright, has led the way in several striking innovations, among others in the use of the "Demand Indicator" method of charging. At Hove, on the other hand, the electric lighting is in the hands of a company. The consumers at Brighton commenced the new year with the following tariff, viz., 7d. for the first hour of maximum demand and 1½d. for all subsequent units. At Hove, across the border, the new year was also inaugurated by reductions in the electric lighting tariff. Nevertheless, at Hove the charge stands at 8d. for two hours' maximum demand, with a four-penny charge for all subsequent units. Of course, there are other considerations besides convenience to consumers when discussing the relative advantages of municipal and joint stock electric lighting enterprises, but naturally price is the consideration which appeals most of all to the consumers.

THE NEWCASTLE ELECTRICAL EXHIBITION.—There was a considerable number of interesting electrical exhibits at the recently opened Newcastle Exhibition. Among these may be noticed particularly a display of Lundell electric motors arranged in a very ingenious fashion. A 20-hp motor derives current from a direct-driven Holmes-Willans steam dynamo and drives by belt a 15-hp machine of a similar type. This latter supplies current to a similar size Lundell motor, which in turn drives by belt a still smaller size, and so on down to a tiny motor of 1-16th-hp, which in turn supplies current for two or three fan motors. This exhibit is made by Messrs. J. H. Holmes & Co., of Newcastle. At the stand of Messrs. Easton, Anderson & Goolden are exhibited the electrical coal cutter and electrical rotary rock drill made by that firm, besides electric lifts, pumps and winding machines. The Roller Bearings Company has a very interesting exhibit consisting of two trucks of exactly similar construction and weight, the one fitted with roller bearings and the other with ordinary bearings. These trucks are mounted on level tracks of short length, and are provided with apparatus for the falling-weight test, by means of which the relatively small friction of the roller-bearing truck is demonstrated conclusively. A still more striking, if less exact test, consists in pushing the trucks with the hand, it being extremely easy to put the roller-bearing truck in motion and somewhat difficult to start the other one. At a large stand a printing machine was shown in operation driven by a Lundell motor. Messrs. Richard Lloyd & Co. exhibit ingenious belt-lacing machines which may be used for fastening solid leather belts. The joint formed consists of wire links and is very flexible. It is also said to possess great tensile strength. The joint is formed by passing the belt ends through a rolling machine in which a special needle first punctures the necessary holes and then feeds a wire across the belt ends so as to form the links. These links are interlocked by means of a straight thread or pin passing between the links alternately across the belt.

General News.

Telegraph and Telephone.

GALENA, ILL.—The Grant County Telephone Company has commenced the construction of a line to Fennimore, Mt. Hope, Millville, Bloomington and Patch Grove.

ASHTABULA, O.—A co-operative telephone system is to be established here. The company which will operate the same has just been incorporated, and is named the People's Telephone Company.

CHICAGO, ILL.—The sub-committee of the City Council who made an inquiry into the right of the Chicago Telephone Company to use slot machine telephones reported adversely against the proposition.

SAUSALITO, CAL.—The Sunset Telephone Company is preparing to string four copper wires from this place to San Rafael. The wires will connect with the cable recently laid between Fort Point and Lime Point.

CHEWELAH, WASH.—The poles for the new telephone line to extend from British Columbia to Spokane are being distributed here and the promoters of the enterprise say that the work will be pushed to early completion.

EATON RAPIDS, MICH.—The application for a franchise for the operation of a local telephone exchange will probably be granted. The new State Telephone Exchange, recently organized, will build the exchange and put in the wires.

OSKALOOSA, IOWA.—R. W. Stewart and a number of local capitalists of Dubuque have applied for a telephone franchise. It will require $50,000 to put in the plant, and it is expected that all wires in the centre of the city will be placed underground.

THE BELLEVUE HOME TELEPHONE COMPANY, Bellevue, O., has been incorporated with a capital stock of $10,000. The incorporators are H. C. Stahl, Jesse Vickey, C. R. Callaghan, W. M. Halliday and D. J. Beck, all of Bellevue. The Company will operate toll lines as well as a city exchange.

HUDSON, WIS.—The City Council has granted to Mr. A. T. Presson a franchise to construct and maintain a telephone exchange in this place to connect with all the principal cities and villages in St. Croix County. The rate to be charged yearly for business instruments is $24, and for residences, $1 per month.

A PARTY OF TELEPHONE MEN from the West interested in companies operating local telephone exchanges in opposition to Bell exchanges, visited New York during the week for the purpose of holding a meeting to discuss the telephone situation. The nature and results of the meeting are not known, but the gentlemen present are all prominent in the "independent" telephone field, among them being Judge James M. Thomas, of Chillicothe, O.; Mr. A. H. Reutinger, manager of the Home Telephone Company, Chillicothe, O.; Mr. George W. Beers, of the Fort Wayne, Ind., exchange; Mr. Hugh Dougherty, president The Studabaker Bank, Bluffton, Ind., and Messrs. Burt Hubbel and J. G. Ihmsen, of the Keystone Telephone Company, Pittsburg, Pa.

Electric Light and Power.

BROOKFIELD, ME.—The Council has under consideration the establishment of a municipal lighting plant.

LE ROY, N. Y.—A special election will be called to decide the question of the village owning an electric light plant.

WILKESBARRE, PA.—The City Council has authorized Charles White, of Philadelphia, to prepare plans for an electric light plant.

RANDOLPH, WIS.—G. W. Bennett and C. A. Nutting have been appointed a committee to report on the cost of an electric light system.

EAST McKEESPORT, PA.—The Borough Council has passed the East McKeesport ordinance to extend its plant for furnishing additional lighting facilities.

TROY, N. Y.—The bill providing that Green Island he bonded for $5,000 to make improvements at the local electric light plant passed the State Senate.

NEW YORK CITY, N. Y.—The bid of the Commercial Construction Company, aggregating $24,000, for the lighting of the Seventh Regiment Armory by electricity, was rejected by the Armory Board. Bids were ordered re-advertised.

MERCHANTVILLE, N. J.—The Borough Council of this place refuses to pay $24 a year for gas lamps for street lighting, and will go back to oil lamps pending the consideration of a proposition to erect a municipal electric lighting plant.

CORNING, N. Y.—The Corning Construction Company, which is composed of New York and Buffalo electricians, has applied to the Common Council for a franchise allowing it the privilege of putting in an incandescent lighting system.

PATERSON, N. J.—Owing to the breaking down of a large piece of shafting at the works of the Edison Electric Illuminating Company, the city was left in darkness on the evenings of March 2 and 3. Only the arc system was affected by the accident.

CHICAGO, ILL.—The Judiciary Committee of the City Council on March 2 took action which will result in placing before the Legislature the question of municipal control and ownership of gas and electric-lighting plants, street railroads and telephones.

CLARKSVILLE, TENN.—A movement is on foot in this place to organize an electric light company, and considerable support is being given to the same. A large amount of stock has already been subscribed for. It is intended to organize the company with a capital stock of about $10,000.

COLUMBUS, OHIO.—The Director of Public Improvements has requested the Superintendent of Lights to report all electric arc lights found to be extinguished for an entire night. The object in view is to secure reductions in the monthly bills for lights not in operation according to the contract.

SALT LAKE CITY, UTAH.—The electrical energy generated at the Utah Power Company's plant in the Big Cottonwood Canon was applied to the operation of street cars in this city on Feb. 25 for the first time. On that date the cars on the Salt Lake City Railway Company's line were propelled by the electric current thus produced.

CAMDEN, N. J.—In his report to the Lighting Committee of the City Council recently, City Engineer Farnham stated that the cost of constructing an electric light plant by the city would be in the neighborhood of $700,000. It is thought that the question of municipal lighting will not be further discussed, at least for the present.

JACKSON, MICH.—At a meeting of the City Council the Electric Light Committee recommended that the Legislature be asked to pass an act enabling the Common Council to raise, by sale of bonds or otherwise, a sum not to exceed $45,000 for the purpose of placing in operation an electric lighting plant. The report was adopted.

THE ELECTRIC RAILWAY.

COXSACKIE, N. Y.—Coxsackie is to have an electric railroad with a capital of $50,000. The line will be five miles in length.

MAYVILLE, N. Y.—The plan to build an electric railway from Mayville to Barcelona via Westfield is again being agitated.

AMITYVILLE, L. I., N. Y.—A new trolley line will be commenced in a short time, extending from Oyster Bay through to Amityville.

KEENE, N. H.—The Board of Aldermen voted to allow the Keene Electric Railroad Company to employ the overhead trolley system.

BALTIMORE, MD.—The Falls Road Electric Railway Company has secured the franchise from the city to build its proposed electric road.

HARTFORD, CONN.—The petition of the trolley company to build connecting lines between Hartford and New Britain has been granted.

NORWALK, CONN.—The Norwalk Street Railway Company will extend its line from East Avenue through Westport Avenue to the town line.

MARCELLUS, MICH.—A franchise has been granted to Dr. F. Schillit, by the village, to put in and operate an electric light system for a term of fifteen years.

CARLISLE, PA.—The franchise desired by the Cumberland Valley Electric Railway Company for the use of streets in Carlisle has been granted by the Carlisle Council.

NEWTON, MASS.—The Watertown Selectmen granted a franchise to the Newton Street Railway Company to lay tracks and operate cars by electricity on Pleasant and Bridge Streets.

NEWBURYPORT, MASS.—Another electric road is in contemplation during the coming season from the High Street line down the Pine Island road to Sandy Beach and Plum Island.

NIAGARA FALLS, N. Y.—Improvements are contemplated by the street railway company here during the coming Summer. New tracks will be laid, the line will b extended and the service otherwise improved.

WHITE PLAINS, N. Y.—The trustees have granted to the White Plains & Elmsford trolley line permission to construct a branch of its road down Lexington Avenue and the Post road.

ORWELL, PA.—The projectors of the Cleveland & Orwell Railway have adopted the following route east of Orwell, to New Lyme, Dodgeville, Andover, Espyville, Conneaut Lake and Meadville.

HAMILTON, O.—The Cincinnati & Miami Valley Traction Company in an official communication to the county commissioners announces its intention of constructing its line from Middletown to this city.

BOYERTOWN, PA.—The Ringing Rocks Electric Railway Company, of Pottstown, has just been granted the right of way by the town council of Boyertown. The line will extend from Ringing Rocks to New Hanover.

MATAWAN, N. J.—The Red Bank & Atlantic Highlands Electric Company has under serious consideration the extension of its trolley line, now running between Red Bank and Belford, from Red Bank through to Freehold.

BOSTON, MASS.—A party of Boston capitalists has recently organized a company for the purpose of constructing a new electric street railway line from Forest Hills to Neponset, where it will connect with the Quincy & Boston line.

NORTH BROOKFIELD, MASS.—At a meeting of the Selectmen it was voted that the town of North Brookfield ask for a franchise for an electric road to connect with the Warren, Brookfield & Spencer electric road at East Brookfield.

LANCASTER, PA.—The Newton, Langhorne & Bristol Trolley Street Railway Company has decided to extend its lines to Parkland, Pa. G. S. W. Brubaker has the contract, and his chief engineer, A. M. Worstall, has finished all the preliminary engineering.

CHICAGO, ILL.—It is reported that the West Chicago Street Railway Company is now prepared to pay, on presentation, at par with accrued interest, any of the certificates of indebtedness issued by the company. It is stated that the company's certificates cover $700,000.

BOSTON, MASS.—The Quincy & Boston Street Railway Company petitioned for a location from the Atlantic depot to Squantum. The company has also asked for a location from the junction of Hancock Street and Quincy Avenue to Howard Street and thence to the Braintree line.

MILWAUKEE, WIS.—Mr. S. M. Williams, one of the incorporators of the North Greenfield & Waukesha Electric Railway Company, states that the company intends to build a line this year between North Greenfield and Waukesha, if the right of way can be obtained at a reasonable figure.

BALTIMORE, MD.—The new car barn of the City & Suburban Street Railway Company on the Frederick road is nearly completed. It will accommodate 250 cars and will be heated by steam and lighted by electricity. The building is 450 feet long and 140 feet wide and is divided into two parts. It is said to be one of the finest street railway structures in the country.

POUGHKEEPSIE, N. Y.—On March 5 an engine on the Poughkeepsie & Eastern Railway backed over a trolley car which was going over the crossing, smashing the car and probably fatally injuring the motorman. A little girl was badly cut by broken glass and her fingers were cut off. Several other passengers on the electric car were injured. When first noticed by the motorman the engine was not in motion, and supposing he had a clear track he attempted to cross it. The engine started and struck the car, derailing it and hurling it against a tree.

Trade and Industrial Notes.

MR. WILLIAM L. HOFF, Washington, N. J., is building up quite an electrical supply business in that city. Mr. Hoff carries a large line of electrical apparatus, including dry batteries, electric bell outfits, etc.

THE DAVIS & EGAN MACHINE TOOL COMPANY, Cincinnati, Ohio, has just received a large order from Stockholm, Sweden, for some 40 machines, amounting to about $22,000; also a large order from Sheriff Swingley & Co., Johannesburg, South Africa.

THE AUTOMATIC CIRCUIT-BREAKER COMPANY, Newaygo, Mich., is doing an excellent business with its circuit-breakers. One reason for this prosperity is the fact that the company guarantees every circuit-breaker sent out, which, if not perfectly satisfactory in operation may be returned.

MR. HERBERT A. MAY, of the Electric Engineering & Supply Company, Syracuse, N. Y., made a flying trip to New York last week, and returned with a pocketful of orders. Both the company and Mr. May are to be congratulated on the promotion of Mr. May to the position of manager and superintendent of the Electric Engineering & Supply Company.

TO GET THE BEST OF BURGLARS.—The Bankers' Electric Protective Company, Chicago, has issued a pamphlet illustrating and describing its automatic electric burglar alarm system, which is designed to protect safes and vaults from the violent intrusion of burglars and other evil-minded persons. The method of accomplishing these results is very ingenious. The company's office is at 52 and 54 Wabash Avenue, Chicago.

BALL ENGINES.—The Hammond Building, Detroit, Mich., will in the future furnish its own electric lighting. The dynamos were furnished by the General Electric Company and the engines by the Ball Engine

Company, Erie, Pa. The Harper Hospital, Detroit, Mich., has recently put in its own electric plant, consisting of two engines built by the Ball Engine Company, Erie, Pa., direct connected to General Electric Company's dynamos.

THE CENTRAL ELECTRIC COMPANY, Chicago, reports that one of the good signs of the times is found in the fact of increasing sales of all kinds of construction and line material. This would indicate a strong probability of lively business when the season opens up. The Company states that it is having a constantly increasing demand for the iron-clad theatre dimmers. The compact design of this apparatus and its ability to rapidly dissipate heat commends it for use under all exacting conditions.

DUTY ON MICA.—Messrs. Eugene Munsell & Co., 218 Water Street, New York City, are making strong efforts to prevent any increase in the duty on mica, which increase is desired by mica miners in this country. The present duty is 20 per cent., and a greater duty, Messrs. Eugene Munsell & Co. argue, would be an additional burden upon the electrical industries. With a view to assisting towards the attainment of their purpose, Messrs. Eugene Munsell & Co. are circulating petitions for signatures.

POWER-TRANSMITTING MACHINERY.—The George V. Cresson Company, 18th Street and Allegheny Avenue, Philadelphia, in a 144-page catalogue describes and illustrates its power-transmitting machinery, shafting and appurtenances. A price-list of the various manufactures is also given. The catalogue includes shafting, clutches, couplings, split collars, balanced pulleys, ball and socket adjustable hangers for vertical shafting, and hangers of all makes. The catalogue is very complete and contains a great deal of engineering information of value.

ANCHOR SWITCHES.—The Electric Appliance Company, Chicago, is just distributing to the trade a catalogue covering a complete line of Anchor snap switches. This is probably the most complete catalogue of snap switches that has been published, and includes a number of new applications of the device; also a complete line of dial or indicating switches. The Electric Appliance Company has prepared a special trade discount sheet for this catalogue, which quotes up-to-date prices on the goods listed. The company will be glad to receive inquiries for the catalogue.

THE CROUSE & HINDS ELECTRIC COMPANY, which was recently organized in Syracuse, N. Y., which organization was noted in our last issue, is composed of Messrs. H. B. Crouse and Jesse Hinds. Mr. Crouse is a bright young man, of good business qualifications, a graduate of Cornell University, and bears an excellent reputation. Mr. Hinds has for years been well known in this part of the electrical vineyard. In 1889 he was one of the organizers of the Electric Engineering & Supply Company, Syracuse, and was chosen vice-president and superintendent of the company, which position he filled up to a short time ago.

THE AMERICAN RHEOSTAT COMPANY, Milwaukee, Wis., has secured the services of Mr. F. E. Herdman, of Chicago, as general manager. Mr. Herdman is an electrical engineer of note and ability, and was until recently second engineer for the Crane Elevator Company, Chicago. The American Rheostat Company is about ready to place upon the market a complete line of improved elevator controllers, crane controllers, automatic pump starters, etc. Its business has expanded to such an extent that it was compelled to seek larger quarters, into which it is now moving. With these increased facilities the Company will be enabled to more promptly meet the large and growing demand for its output.

THE FISCHER FOUNDRY & MACHINE COMPANY, Pittsburg, Pa., builders of the "Fischer" single and four valve engines, desire us to contradict certain unfounded reports that have been in recent circulation, to the effect that the manufacture of engines has been discontinued by the company. On the contrary, it is stated that additional features have been introduced, which, combined with those of the original make of these engines, especially adapt them for electric lighting and street railway purposes. The company reports a thriving and prosperous business, with a flattering outlook for 1897. The general Western agency of these engines is in the hands of Foster & Louis, Fischer Building, Chicago.

THE BALL & WOOD COMPANY, engine builders, 120 Liberty Street, New York, reports that the inquiry for its engines is growing apace with the generally improved business outlook. This company has recently entertained buyers from South America and from Japan, where great interest is manifested in its engines, not only because they are better finished and more complete in detail than European products, but also because they are better proportioned and more efficient. When such home institutions as the New York Clearing House and the National Bank of Commerce use the Ball & Wood engines for lighting their buildings, it is no wonder that foreigners are impressed with these machines.

BRUNT & THOMPSON.—The regulating sockets manufactured by Brunt & Thompson, East Liverpool, Ohio, are meeting with great success all over the world, so we are informed. The firm has installed these sockets in several hospitals, all of which report obtaining the desired effects from the use of the same. There has been a great demand for such a device for use in institutions of this character. The only difficulty Brunt & Thompson have experienced so far is that they cannot manufacture these sockets fast enough to keep their customers satisfied. The trade is also rapidly appreciating the fact that it pays to use the B. & T. porcelain cleats and tubes. These goods are claimed to be unsurpassed, and the firm is proud of its reputation of being able to promptly fill orders for the same on receipt of the order. They are enabled to do this by reason of the large and complete stock they carry on hand at all times.

A GIANT CATALOGUE.—The 1897 tool catalogue and price list just issued by Montgomery & Co,, 105 Fulton Street, New York City, dealers in tools, supplies and machinery, may justly be classed among the largest trade productions of the kind ever issued. It contains 710 pages, and descriptions and illustrations of about everything imaginable in the hardware and tool line. At the back of the book is given considerable information of value, in the form of tables of weights, measures, etc., and following this comes an excellent index of the contents, which covers no less than 10 pages. The size of the catalogue is 8 inches by 10½ inches, and it is neatly and strongly bound in yellow canvas boards. It is one of the most complete catalogues we have ever seen, and reflects great credit upon the house that produced it. The first copy from the printer was delivered to Montgomery & Co. on the day of President McKinley's inauguration, and for this reason it has been dubbed "The Advance Agent of Prosperity."

QUICK WORK.—In the recent disastrous fire which entirely destroyed the principal power house of the Union Traction Company, Philadelphia, on the night of Mar. 3, there were a number of I-T-E circuit breakers, as well as circuit breakers of other makes and types. While the fire engines were still playing upon the flames Mr. Charles Hewitt, chief electrician of the Union Traction Company, placed himself in communication with the Cutter Electrical & Manufacturing Company, Philadelphia, and ordered for immediate delivery 165 I-T-E circuit breakers. This order was provisional upon prompt delivery, as required by the Traction Company. Inside of 24 hours 116 of these circuit breakers were delivered to the Traction Company. It would seem that comment upon the merits of the I-T-E circuit breaker and the size of the Cutter Company's business, which would enable it to fill this order—one of the largest ever placed at one time for circuit breakers—is unnecessary. The fact that standard switchboard types were ordered made it possible for the entire order practically to be filled out of stock.

HENRY R. WORTHINGTON, Brooklyn, N. Y., manufacturer of steam and electric pumping machinery, has recently received a contract from the Newport News Ship Building & Dry Dock Company, amounting to $100,000, covering pumps for the U. S. battle ships, "Kearsarge," "Kentucky" and "Illinois." He is also building the pumps and pumping machinery for the U. S. battle ship "Alabama," now being constructed by the Wm. Cramp & Sons Ship & Engine Building Company. The contract for the pumps for this vessel amounts to $33,000. The company has just completed and delivered the hydraulic machinery for operating the turrets on the U. S. battle ship "Iowa." It has more recently received a contract amounting to $15,000, covering the pumps required for the armored cruiser being built by the Wm. Cramp & Sons Ship & Engine Building Company, for the Japanese Government. The "Yoshi-No," another Japanese cruiser, is already fitted out with a full complement of Worthington pumps. The fact that with few exceptions all British and other foreign war vessels are equipped with these machines simply adds another testimonial to the high efficiency of the Worthington Duplex Steam Pump.

MESSRS. JAS. C. WORMLEY & CO., whose general offices are in the Marquette Building, Chicago, have closed a contract with The Shelby Electric Company, Shelby, O., whereby they are to have the sole agency for the Shelby tipless lamp in Cook County, Ill., and also in Minnesota. It is Mr. Wormley's intention to carry a large stock of Shelby lamps in Chicago as well as in St. Paul, where his Company has a well-established agency. Mr. Wormley has been connected with the incandescent lamp business for several years, and is one of the largest exclusive dealers in that line in the United States. He was the Western agent of the Universal Electric Company until the Universal was burned out of existence. As Mr. Joseph Hardwick, formerly superintendent of the Universal factory, is now connected with The Shelby Electric Company, Mr. Wormley feels that he is in a position once more to supply his old customers with a lamp manufactured after his own ideas. In addition to the Shelby agency, Jas. C. Wormley & Co. will continue to market the Wormley lamp in all territory. This lamp is made up in lower efficiency than the Shelby lamp (running from 3 to 4 watts per candle-power), but has a double-coiled filament (showing two turns). It is said that since they commenced advertising this lamp at a discount it has become very popular, both in the East and West.

THE BURNLEY BATTERY & MANUFACTURING COMPANY, Painesville, Ohio, announces that it has reduced the price of this well-known dry cell to meet the competition of other makes. This reduction will no doubt result in a large business in this well-known battery. The company has several flattering testimonials as to the efficiency and adaptability of this cell to the various requirements of a battery of this class. The General Electric Company, Limited, London, England, is the sole agent for that country for the Burnley battery and has been acting in this capacity for some six or seven years. This fact alone is a testimonial to the excellence of the Burnley battery and the popular favor which it enjoys in that country. Mr. William Burnley, manager of the company, has had a long experience with dry batteries and is the patentee of the Burnley cell. He was the first to bring it to the notice of the public. It is said to possess all of its original excellence, which, together with such modifications of structure as a large experience and diligent application to this class of work has shown to be of any value, is a guarantee that the product can be depended upon. The company will be glad to furnish on application reports of tests made upon this battery by one of the best electrical engineers in England, and testimonials from the best supply houses in the trade.

NEW ELECTRICAL HOUSE IN BUFFALO.—A co-partnership has been formed between Mr. J. F. Kester, of the Kester Electric Manufacturing Company and Mr. Wells Dygert, of the Buffalo Electric Company, both of Buffalo, N. Y. Both of these houses will continue business as heretofore but under one management—that of the Buffalo Electric Company. Mr. Dygert is sole owner of the Buffalo Electric Company, which has conducted an electrical supply and construction business for the past twelve years. He has an excellent business reputation

and is exceedingly popular in the trade, being a 32 degree Mason, a Shriner, a Knight Templar and a Grand Army veteran. Mr. J. F. Kester is a native of Illinois, where he was born in 1852. In 1886 he associated himself with Prof. L. I. Blake (then Professor of Physics at the Rose Polytechnic Institute, Terre Haute, Ind.) in the manufacture of Kester's anti-magnetic watch shield, and at the same time carried on extensive experiments at the Institute with telephone transmitters and methods of communicating between vessels at sea. In 1887 Mr. Kester designed a line of slow speed multipolar dynamos and motors, and organized the Kester Electric Company at Terre Haute, Ind., which is still manufacturing the same under several patents granted to Mr. Kester. This concern is a prosperous one. In 1892 Mr. Kester sold his interest in the Terre Haute Company and moved to Chicago, where he organized the Kester Arc Lamp & Manufacturing Company, and obtained several patents on arc lamps. This company was subsequently absorbed by the F. P. Little Electric Construction & Supply Company, Buffalo, N. Y., which carried on the manufacture of the Kester arc lamp under the supervision of Mr. Kester himself, until 1896, when the patents were sold to the General Electric Company. Mr. Kester then went into the manufacture and sale of a line of electrical specialties on his own account, and his business rapidly developed and met with phenomenal success.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 67-71 Park Place, New York City.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, 105 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED MARCH 2, 1897.

(In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

577,853. TROLLEY POLE CONTROLLER; L. M. Halsey, Brooklyn, N. Y. App. filed July 20, 1896. The trolley pole and jaws thereon and a trolley wheel mounted between the jaws with liberty to rise and sink therein, in combination with a spring-actuated reel carried by said jaws and near said wheel, a ratchet wheel on the reel-shaft, a pawl pivoted on one of said jaws with one end connected to the wheel-support and the other adapted to engage or release said ratchet wheel as the trolley wheel sinks or rises, and a trolley rope attached at one end to the car and at the other to said reel.

577,864. ALTERNATING CURRENT ARC LAMP; E. R. Knowles, Brooklyn, N. Y. App. filed Aug. 19, 1896. The method of starting an alternating current arc lamp in operation, which consists in holding the carbons in contact after the current is turned on long enough to allow the carbons to become heated sufficiently to maintain the normal arc and then slowly separating the carbons to establish the normal arc.

577,872. ELECTRICAL CAR LIGHTING; M. Moskowitz, Newark, N. J. App. filed Dec. 23, 1896. The combination with a car-wheel axle and truck-frame, of a dynamo on said frame, having an armature shaft and a pulley-wheel thereon, a pulley-wheel on said car-wheel axle and a counter-shaft in brackets secured to the car-truck, a pulley-wheel on said counter-shaft, all of said pulley-wheels being in alignment, and a belt passing around the dynamo pulley and the pulley on said counter-shaft and in frictional contact with the upper surface of the pulley-wheel on the car-wheel axle, said pulley-wheel on the car-wheel axle being adapted to be removed without moving the belt.

577,885. ELECTRICAL RAILWAY; C. Skinner, Chicago, Ill. App. filed May 27, 1896. In an electric railway the combination with a sealed receptacle, an insulated current wire, a lateral branch therefrom entering said receptacle and a circuit-closing bolt movable bodily vertically, but normally depressed in said receptacle, of a car, motor therefor and devices carried by said car for directly engaging the top of and lifting said bolt so as to bring the same in electrical contact with said lateral branch and close the circuit therethrough between said current wire and car.

577,912. ELECTRIC RAILWAY; S. G. Brosius, Baltimore, Md., and W. B. Upton and J. Colvin, Washington, D. C. App. filed Feb. 25, 1896. In an electric railway, a car adapted to travel thereon provided with a propelling motor, positive and negative conductor rails for the electric current, a contact box provided with automatically adjustable contact bars, a plow adapted to be connected with said contact box, and in contact with said adjustable contact bars, and adapted to move in contact with said conductor rails to carry the electric current to and from said motor for propelling the car, and means for disengaging said plow from said contact box.

577,920. TELEPHONE CALL REGISTER; W. A. Heckard and D. Ogden, Columbus, Ind. App. filed June 8, 1896. In a sender for a telephone call register, a shaft forming part of an open electric circuit, a series of contact-wheels secured to said shaft, each of said contact-wheels being provided with a series of contact-points also forming a part of said open circuit, means for causing said terminal to engage with the series of contact-points upon any one of said contact-wheels, an electric motor connected with said shaft, a terminal forming a part of the open motor-circuit, a lever also forming a part of said motor-circuit, means operated by the movement of said first-mentioned terminal for causing said lever to engage said last-mentioned terminal and thereby close the motor-circuit, a cam secured to the shaft and adapted to engage said lever, the said cam operating, during a portion of its revolution, to hold said motor-circuit closed, and also operating to open said motor-circuit.

577,921. TROLLEY-CATCHER; T. Holahan, Rochester, N. Y. App. filed July 11, 1896. In a trolley-catcher, the combination of an open-ended air-cylinder provided with a discharge orifice, a slide movable forward and back, a piston attached to the slide adapted to enter the open end of the cylinder, a connection attached to the slide, a spring roller on which the connection winds, a spring hook at the top of the casing, and a corresponding hook on the slide, which two hooks engage together when the slide is raised, a latch for operating the spring hook, a cord connecting the slide with the trolley arm, and another cord connecting the latch with the trolley arm.

577,949. DANGER SIGNAL; D. A. Gordon and B. B. Weir, Cassopolis, Mich. App. filed Aug. 29, 1895. In a railway signal, the combination with the track-supporting frame-work of a lever mounted in said frame-work, cables suspended over the track, signals mounted to travel upon said cables, an electric circuit, signal-operating mechanism included with a source of electricity in said circuit, and mechanism connecting said lever with said circuit, whereby by a movement of said lever the circuit is effected to cause a display of said signals.

577,950. DOUBLE-POLE REVERSING SNAP-SWITCH; H. A. Gorn, New York, N. Y. App. filed Aug. 6, 1894. In an electric switch, the combination with the main-line terminals of the working terminals, intermediate insulated contacts between each main-line terminal and working terminal, and a rotating portion provided with connecting-contacts arranged to complete the circuit between each main-line terminal and working terminal through the intermediate contacts, thereby including the intermediate contacts in the circuit on each side of the working terminals.

578,004. IGNITING DEVICE; A. Czarnikow, Berlin, Germany. App. filed Feb. 26, 1896. In an electric gas-lighter, the combination with the gas supply of an elastic sleeve surrounding it, a valve chamber, a valve which is pressed into opened position by a spring, an electromagnet for shutting off the supply of gas, the armature for said magnet, which armature acts on the valve, electromagnets for opening the supply of gas and igniting the gas, an armature for said magnet, which armature acts on the valve, electromagnet for open-ture in closed position, whereby the armature when attracted by its magnet releases the armature and permits the spring to open the valve.

578,006. TABLE TELEPHONE APPARATUS; L. M. Ericsson, Stockholm, Sweden. App. filed Oct. 27, 1896. In a telephone apparatus, the combination of the rotary core, the pole-pieces and the horse-shoe magnets attached thereto at each end, said magnets extending downwardly from the core and having broadened and spreading base portions to serve as supporting feet.

578,016. COMMUTATOR BRUSH; J. F. Kester and F. C. Atherton, Buffalo, N. Y. App. filed June 16, 1896. A commutator brush consisting of a corrugated core and a wire gauze covering surrounding the core.

578,069. ELECTRIC MOTOR; H. A. Stock, Millersburg, Penn. App. filed April 15, 1896. An alternating-current motor, all of whose field-poles are at any instant of the same sign, in combination with two sets of armature-poles, which at any given instant are of opposite sign, and coils wound on all of the said poles connected to a source of alternating current.

578,073. POROUS DIAPHRAGM; H. Blumenberg, Jr., Wakefield, N. Y. App. filed Nov. 15, 1895. The method of making diaphragms, consisting of treating asbestos with acid to remove the metallic salts and toughen it, combining a binding material with the asbestos, forcing the binding material into the pores of the asbestos under high pressure, and finally baking it at high temperature, which changes the asbestos from a fibrous into a crystalline state.

578,077. TESTING APPARATUS FOR ELECTRIC AUTOMATIC SYSTEMS; C. Burgher, Newton, Mass. App. filed Dec. 17, 1896. In a testing apparatus, the combination of the following instrumentalities, viz.: An inclosing case provided with a door, a recording surface located within said case, a stylus or marking device co-operating therewith, an electromagnet to operate said stylus, a plurality of circuit controllers located in said casing, and each included in an independent circuit, a circuit terminal co-operating with the circuit controllers, an electromagnet included in circuit with the said circuit terminal, a disc or dial having openings in line with the said circuit controllers, and a movable arm or pointer provided with a plunger or arm adapted to enter said openings and move one member of the said circuit controllers into engagement with the said circuit terminal.

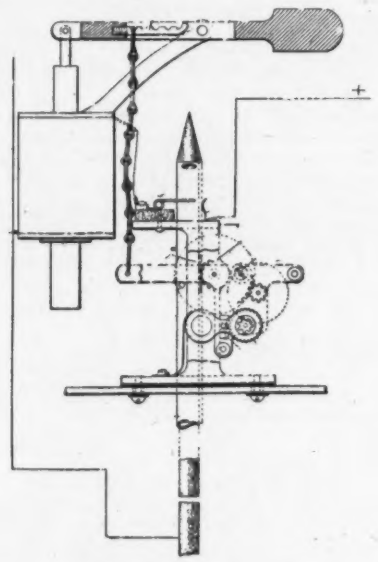
578,107. ELECTRIC LAMP; M. M. Kohn, Chicago, Ill. App. filed Dec. 4, 1895. In an electric lamp the combination with a case to contain a battery, of a cap detachably fitted over the top of said case, contact-pieces connected to the positive and negative elements and

mounted upon an insulating plate which forms a seal for the battery, contacts mounted upon the detachable cap and electrically engaged with the contacts upon the seal-plate when said cap is fitted upon the case, and a hand-operated switch pivoted upon the cap to cut the lamp into and out of circuit.

578,113. MESSAGE-RECORDING INSTRUMENT; B. J. Noyes, Boston, Mass. App. filed June 25, 1896. In a message-recording instrument, adapted to be connected with and operated by several signaling circuits, the combination of time-printing indicators and a platen, a paper-feeding device for feeding a strip of paper between them, electro-magnetically operated marking devices, one for each circuit connected with the instrument, located close to said time-printing indicators, for recording a message on the moving strip of paper, a motor mechanism for operating said paper-feeding device, a starting magnet for releasing it, common to all the circuits, a cam secured to one of the shafts of said motor mechanism, and a lever actuated by its bearing said platen.

578,114. ELECTRIC SIGNALING APPARATUS; B. J. Noyes, Boston, Mass. App. filed July 11, 1896. In an electric signaling apparatus, a main signaling circuit, signal-transmitting devices for operating said circuit adapted to transmit a differentiating impulse with some signals and not others, and a signal-receiving instrument for receiving all the signals, combined with an auxiliary circuit, a signal-receiving instrument operated by it, an automatic switch for controlling the operative condition of said auxiliary circuit, means for operating said switch controlled by the differentiating impulses, a restoring device for said switch, and means for operating said auxiliary circuit operated by the main signaling circuit.

578,115. ELECTRIC SIGNALING APPARATUS; B. J. Noyes, Boston, Mass. App. filed July 21, 1896. In an electric signaling apparatus, a number of main signaling circuits, signal-transmitting devices for operating them adapted to transmit a differentiating impulse with some signals and not with others, and a signal-receiving instrument for receiving all the signals of all the circuits, combined with an auxiliary circuit, a signal-receiving instrument operated by it, a number of switches for controlling the operative condition of said auxiliary circuit, corresponding to the number of main signal circuits, means for operating said switches controlled by the differentiating impulses, and an independent restoring device for each switch, and a number of circuit-operating devices for said auxiliary circuit, corresponding to and operated by said main signaling circuits.



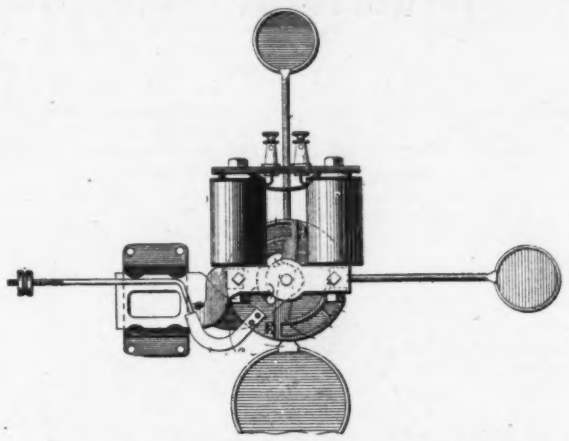
No. 577,864.—Alternating Current Arc Lamp.

578,122. COMBINED TELEPHONE AND ANNUNCIATOR SYSTEM; J. R. Strong, New York, N. Y. App. filed July 31, 1896. A switch having a series of yielding contact-arms and a corresponding series of stationary contacts with circuit connections running to independent calling circuits, and an annunciator provided with an independent drop for each pair of such contacts, in combination with controlling mechanism having movement over said yielding contacts, and provided with an indicator adapted to indicate the number of circuit to be controlled or effected.

578,126. TELEGRAPHY; R. H. Weiny, Arlington, N. J. App. filed Sept. 4, 1896. In a system of telegraphy, means located at a transmitting station for transmitting Morse characters over a main line joining the same with a receiving station; means located at the receiving station for making upon a record-strip a permanent record of said characters, and consisting of electromagnetic apparatus controlled by the current impulses transmitted, and mechanism for continuously moving the record-strip under a stylus carried by the armature of said electromagnetic apparatus, in combination with mechanism for independently continuously moving the completed record-strip in such manner as to successively actuate a Morse sounder included in a local circuit, both of said mechanisms being driven by a single source of power, as an electric motor, and provided with regulating mechanism for varying the speed at which they are driven.

578,182. APPARATUS FOR REGULATING AND MODIFYING ELECTRIC CIRCUITS; G. F. C. Adam, Hanover, Germany. App. filed July 7, 1896. In an electric car, deriving its motive current partly from a line wire and partly from a storage battery, which in turn is charged from the line wire during the trip, a current-switching device, composed of a main switch for connecting the motor with the line wire or storage battery, and also connecting the battery with the line wire, and two additional switches, of which one controls the motor and resistance and the other switches the battery in series or parallel, which two switches are so connected as to permit each to perform its function but to the initial position together.

578,233. ELECTRIC ARC LAMP; A. Guendel, New York, N. Y. App. filed July 7, 1896. In an electric arc lamp, a rotating shaft on a base-plate, two simultaneously rotating gear-wheels or friction rollers with different diameters, having their outer peripheries beveled and being attached to the said shaft, and two ratchet or friction bars guided in casting attached to the base-plate and having their contact edges beveled to correspond with the bevels of the gear-wheels or friction rollers, one of the bars being engaged by one gear-wheel or friction roller, and the other one by the second gear-wheel or friction roller, in combination with carbon-holding brackets attached to the said ratchet-bars.

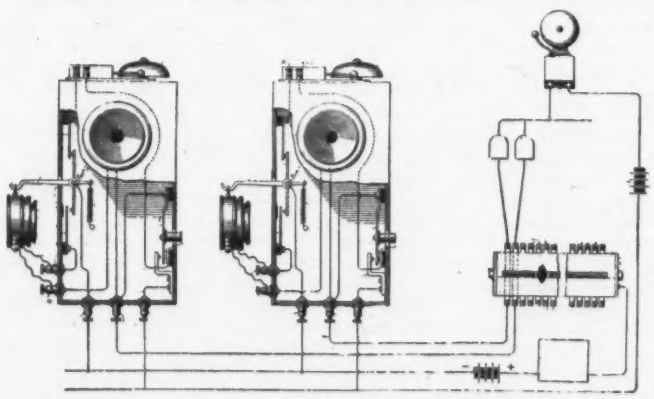


No. 578,236.—Railway Signal.

578,236. RAILWAY SIGNAL; W. P. Hall, Greenwich, Conn. App. filed Nov. 28, 1892. In a railway signal, the combination of a casing having two registering apertures, one in front and one in back of the casing, for a day signal, and having a third aperture in front for a night signal, a day-signal disc within said casing, movable before and away from its apertures, and mounted upon a shaft with two or more night-signal discs, mounted upon the same shaft, and adapted to be made visible at night through said third aperture.

578,275. ELECTRIC CIRCUIT; J. S. Stone, Boston, Mass. App. filed Sept. 10, 1896. The combination with an air-line electric conductor having definite capacity and self-induction, of a cable conductor consisting of an electric conducting core provided with a longitudinal discontinuous paramagnetic sheath of such dimensions as to so increase the self-induction of the conducting core that the ratio of the capacity to the self-induction of the conducting core shall be equal to the ratio of the capacity to the self-induction of the air-line conductor.

578,280. DYNAMO ELECTRIC MACHINE AND ELECTRIC MOTOR; C. P. Turner, New York, N. Y. App. filed Nov. 25, 1895. The method of increasing the permeability of the field-magnets of dynamos and electric motors, which consists in electrically depositing on the polar extremities of the field-magnet a coating of iron.



No. 578,122.—Combined Telephone and Annunciator System.

578,304. ELECTRIC RAIL-BOND; B. J. Jones, Chicago, Ill. App. filed April 29, 1896. An electric rail-bond, comprising a loop-shaped body portion, formed of a series of strands or bars arranged side by side, so as to have lateral compactness, and rivet-studs secured by casting or otherwise to the ends of such body portion and arranged to project laterally therefrom.